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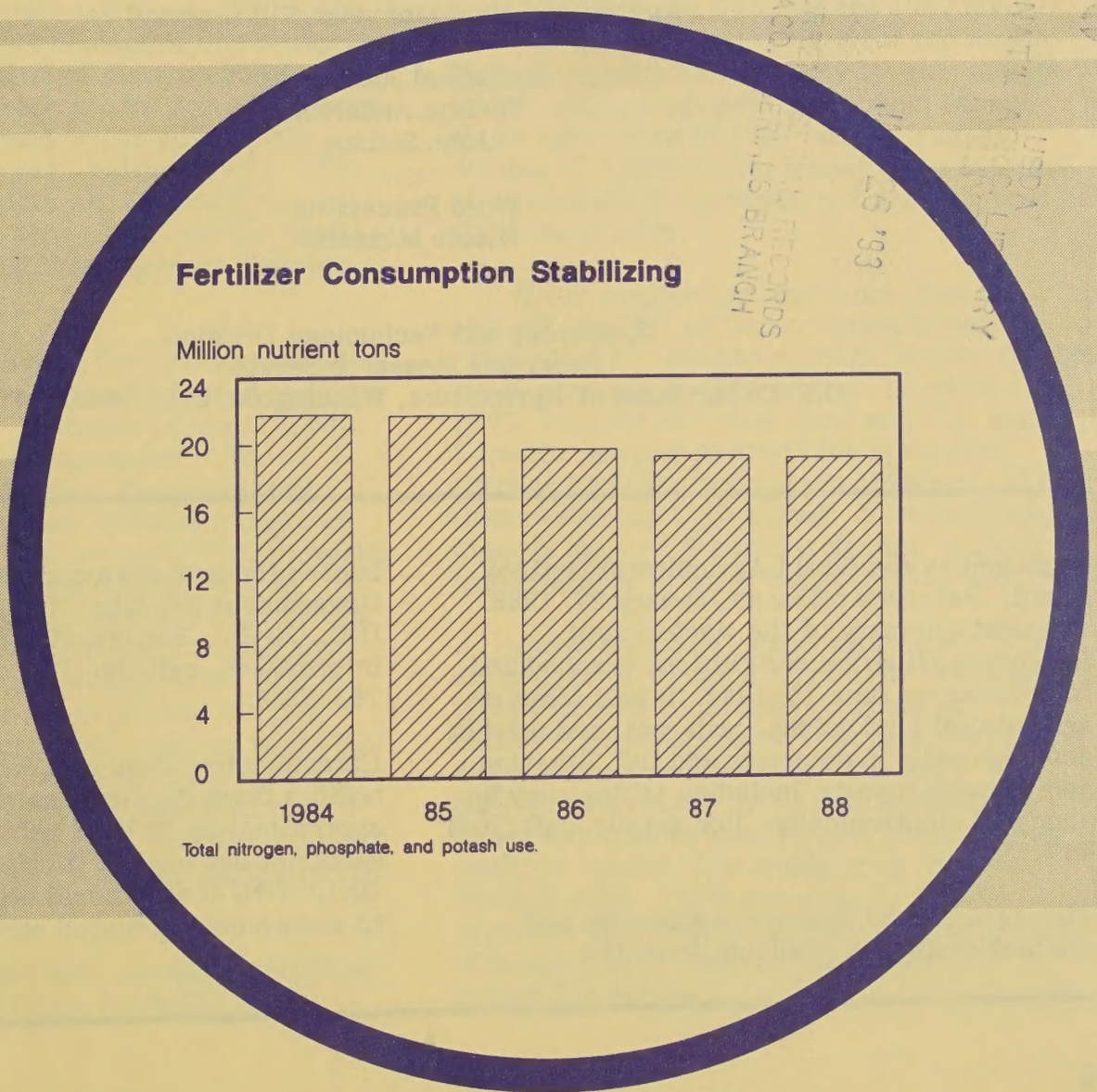

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U.S. fertilizer consumption during 1987/88 is projected to remain close to year-earlier levels, following a 2-percent decline in 1985/86. Nitrogen, phosphate, and potash use are projected at 10.4, 3.9, and 4.8 million tons, respectively. Stable fertilizer use is tied to steady application rates and little change in planted crop acreage because of continued heavy farmer participation in acreage reduction programs.

Domestic nitrogen and phosphate fertilizer supplies are expected to tighten in relation to use in 1987/88, and prices will average above a year earlier. While domestic fertilizer demand remains stable, U.S. production of nitrogen and phosphate will rise as a result of increased export demand induced by the lower dollar. July-November nitrogen exports surged, led by increased shipments of anhydrous ammonia, urea, diammonium phosphate, and nitrogen solutions. The rise in U.S. phosphate export demand is due primarily to increased shipments of diammonium phosphate. U.S. potash production will change little in 1987/88, while prices will remain substantially above year-earlier levels. This spring, fertilizer prices are expected to average 10 percent above year-earlier levels, after rising 3 percent from April to October 1987.

Worldwide growth in fertilizer production, consumption, and trade is anticipated over the next several years. Nitrogen production will continue to exceed consumption in the developed countries, while the developing countries will realize net deficits in spite of production growth. By the early 1990's, world growth in nitrogen demand could exceed increases in supplies, leading to higher prices. World supplies of phosphate and potash are expected to be more than adequate. The developed countries are projected to have excess phosphate fertilizer supplies, while the Soviet Union, Asia, and Eastern Europe will be deficit areas. The greatest potash surplus is forecast for North America. Western Europe, Asia, Africa, and Latin America are projected to be deficit areas.

Agricultural pesticide use for major field crops in 1988 could range from 420 to 464 million pounds active ingredient (a.i.), compared with an estimated 429 million pounds in 1987. The proportion of acres treated with herbicides and insecticides in 1987 remained near year-earlier levels. Pesticide manufacturers surveyed last fall indicated that spring herbicide prices may be up 2 percent from last year, and insecticide and fungicide prices 1 percent. Domestic availability of pesticides is expected to be down 14 percent from last year's large supplies. Manufacturers have been reducing production and inventories as planted acres have declined. Pesticide exports are projected to be up 11 percent in 1988, primarily because of the dollar's decline.

In 1987, more than 5.9 million tons of seed were used for the major U.S. field crops, 10 percent less than in 1986. Total seed use is expected to be unchanged in 1988, with crop acreage remaining at about the 1987 level. Seeding rates and seed prices for the major field crops vary substantially by crop and by State. Seed prices paid by farmers for the major field crops in 1987 ranged from a decline of 7 percent for wheat to an increase of 3 percent for soybeans, but are expected to stabilize in 1988.

Grass seed prices rose more than 25 percent in 1987, as Conservation Reserve Program (CRP) seeded acreage increased from 2 million acres in 1986 to near 16 million in 1987. Imports of forage seed and U.S. and Canadian grower requests for grass seed acreage certification rose in 1986 and 1987 in response to the CRP signup. Increased seed imports led to a 4-percent decline in the U.S. trade balance in seeds between 1985 and 1986.

Farm machinery expenditures for 1988 are projected to stabilize at 1987 levels as farm financial conditions continue to improve. It is estimated that farm machinery expenditures were down for the 8th consecutive year in 1987, but the decrease likely was smaller than in past years. Farm equity is expected to continue to improve through 1988. Farm net cash income is expected to remain at a relatively high level, although 5 to 10 percent lower than 1987's record $57 billion.

Lower production rates for 40-99 hp two-wheel drive tractors and sales incentive programs for over-99 hp two-wheel drive tractors enabled manufacturers to lower September-to-September inventories relative to sales to an 8 and 6-month supply, respectively. Because of a sharp drop in self-propelled combine sales, inventories relative to sales rose 28 percent from a year ago, resulting in a 10-month supply.

The United States posted a $138-million farm machinery trade deficit for the first 9 months of 1987, up 21 percent from a year earlier. Export value increased 3 percent to roughly $1.2 billion, behind increased shipments to Canada, South America, Western Europe, and Saudi Arabia. But import value edged upward 5 percent from the previous year to $1.3 billion . Because wheel tractor trade accounts for at least 50 percent of the value of farm machinery exports and imports, it is the most important factor influencing farm machinery trade.

The falloff in oil prices to below $17 per barrel underscores the volatility of the oil market, which had experienced relatively stable prices in most of 1987 following wide swings in 1985 and 1986. U.S. farmers can expect energy prices to remain steady, and possibly edge downward through the spring following sharply lower crude oil prices in fourth-quarter 1987. Farm energy expenditures are expected to remain at last year's level. Slightly lower energy prices are likely to offset increased acreage of energy-intensive crops, such as cotton and rice, thus halting a 7-year decline in farm energy expenditures.

FERTILIZER

Demand

U.S. plant nutrient consumption in 1987/88 (July 1987 - June 1988) likely will remain close to year-earlier levels. Use is forecast at 10.4 million tons for nitrogen, 3.9 million tons for phosphate, and 4.8 million tons for potash. During 1986/87, farmers used 10.3 million tons of nitrogen, 4.0 million tons of phosphate, and 4.9 million tons of potash.

Total cropland acreage in 1987/88 is estimated to remain about the same as in 1986/87, with fertilizer application rates remaining close to 1986/87 levels. Farmer participation in Government commodity programs is expected to be close to year-earlier levels. Last year, about 74 million acres of farmland were idled under two provisions of the Food Security Act of 1985: the conservation reserve program (CRP) to remove erodible land from production and the crop set-aside program that reimburses farmers for not planting designated crops. However, in mid-December 1987, the House and Senate Agricultural Committees reached a compromise aimed at satisfying the Gramm-Rudman budget requirements. The compromise package includes small adjustments in target prices and loan rates as well as an optional diversion program called 0/92.

Wheat and feedgrain farmers will have the option of planting no crops and receiving 92 percent of the deficiency payments they would otherwise have received by planting all program-eligible acres. For example, farmers producing corn could elect the 0/92 program after setting aside 20 percent of their base acres under the acreage reduction program and an additional 10 percent paid land diversion, while wheat growers could elect the program after setting aside 27.5 percent of their base acreage. Wide participation in the 0/92 program could substantially reduce plant nutrient consumption; however, 1988 farm crop prices are expected to be high enough for most farmers to plant crops rather than participate in the 0/92 program.

Additionally, acreage will continue to be entered into the CRP during 1987/88. Acreage going into the CRP will require some fertilizer to establish permanent cover.

Exports of nitrogen fertilizer during 1987/88 are expected to increase 20 percent from a year earlier as exports of anhydrous ammonia, urea, diammonium phosphate and nitrogen solutions have surged. Phosphate exports may rise 4 percent if the current

strength in diammonium phosphate exports continues. Potash exports could be close to year-earlier levels as higher prices offset the decline in the value of the dollar.

Supplies

Domestic supplies of all fertilizers are expected to be adequate to meet 1988 crop needs. U.S. nitrogen and phosphate fertilizer production capacity will be more fully utilized in 1987/88, while operating rates for potash will approach year-earlier levels. Current production rates indicate that almost 93 percent of anhydrous ammonia capacity, estimated at 16.7 million tons, is being used. Wet-process phosphoric acid facilities capable of producing over 11.5 million tons are operating at about 87 percent of capacity. Around 84 percent of U.S. potash capacity (1.8 million tons) and about 59 percent of Canadian capacity (12.6 million tons) is being used.

A year earlier, anhydrous ammonia plants operated at 81 percent of capacity, while facilities producing wet-process phosphoric acid operated at about 85 percent. Meantime, operating rates for U.S. and Canadian potash producers stood at 85 and 53 percent, respectively. Any further increases in 1987/88 nitrogen and phosphate operating rates will depend on the continued strength of the export market, since domestic fertilizer demand is expected to remain relatively flat.

U.S. nitrogen production is projected to increase by 7 percent in 1987/88 as domestic demand stabilizes and strength in the export market continues (table 1). Lower natural gas prices paid by many U.S. anhydrous ammonia producers during most of 1987 allowed them to be more competitive internationally. As nitrogen supplies in the world market tightened, U.S. nitrogen exports increased by over 32 percent in 1986/87. However, natural gas prices paid by U.S. anhydrous ammonia producers increased during the fourth quarter of 1987 as producer contracts expired, demand surged due to cold weather, and supplies tightened. Further gas price increases should be tempered by abundant oil supplies. Oil can be substituted for gas in commercial and industrial use and electrical generation. These substitutions provide some cost protection to firms that use gas as a feedstock to manufacture higher valued products such as anhydrous ammonia.

U.S. nitrogen imports could decline by 3 percent in 1987/88, following an 8-percent decline in 1986/87. While imports of nitrogen declined by almost 7 percent through November of the 1987/88 fertilizer year, expected increases in natural gas prices to domestic nitrogen producers will allow nitrogen producers in low-cost production areas outside the United States to compete more effectively with U.S products for the remainder of 1987/88. This impact will be tempered, however, as the falling dollar raises the effective price of imported nitrogen.

In 1986/87, nitrogen fertilizer production decreased in response to lower prices. Anhydrous ammonia production declined 3 percent to 15.2 million tons, while production of ammonium nitrate and nitrogen solutions fell 7 and 2 percent, respectively (table 2). Urea was the only major nitrogen fertilizer product showing an increase over 1985/86.

U.S. phosphate production is expected to increase about 6 percent in 1987/88 in response to higher prices and strength in the export market. Inventories are also lower than a year earlier. Total production of selected phosphate fertilizer materials in 1986/87 increased 6 percent from a year earlier as exports increased by 36 percent over the depressed levels of 1985/86. Diammonium phosphate production increased 7 percent while production of triple superphosphate rose 4 percent. Production of normal and enriched superphosphate, while accounting for only a small proportion of total production, increased 140 percent. In contrast, monoammonium phosphate production declined 4 percent.

In 1987/88, U.S. potash production will likely approach year-earlier levels as domestic and export demand change little. Despite a preliminary determination against Canadian producers in an anti-dumping suit in August 1987, potassium chloride imports from Canada during July - November 1987 stood at 94 percent of year-earlier levels. Potash imports from all sources through November 1987 were up almost 2 percent. Total U.S. potash imports for 1987/88 should resemble year-earlier levels as Canadian suppliers maintain their share of the U.S. market.

Table 1--U.S. supply-demand balance for years ending June 30

Item	Nitrogen			Phosphate			Potash		
	1986	1987	1988 1/	1986	1987	1988 1/	1986	1987	1988 1/
	Million nutrient tons								
Producers' beginning inventory	1.42	1.88	1.36	0.77	0.63	0.51	0.30	0.29	0.22
Production	12.82	12.43	13.25	3/ 9.07	3/ 9.44	3/ 10.00	1.21	1.34	1.34
Imports	4.14	3.81	3.69	3/ 0.11	3/ 0.11	3/ 0.14	4.87	4.35	4.38
Total available supply 2/	18.39	18.13	18.30	9.94	10.18	10.65	6.38	5.99	5.94
Agricultural consumption	10.42	10.35	10.40	4.18	4.01	3.90	5.05	4.85	4.75
Exports	2.05	2.71	3.26	3/ 3.16	3/ 4.28	3/ 4.45	0.49	0.65	0.64
Total agricultural and export demand 2/	12.47	13.06	13.66	7.34	8.30	8.35	5.55	5.50	5.39
Producers' ending inventory	1.88	1.36	1.30	0.63	0.51	0.50	0.29	0.22	0.20
Available for non-agricultural use	4.04	3.71	3.35	1.98	1.38	1.80	0.54	0.27	0.34

1/ Forecast. 2/ Totals may not add due to rounding. 3/ Does not include phosphate rock. In addition, does not include exports of superphosphoric acid because of a data reporting change by the U.S. Department of Commerce in July 1985. Thus, phosphate exports are understated and domestic supply is overstated.

Source: (1, 2, 5, 6, 7).

Farm Prices

Spring 1988 fertilizer prices are expected to average 7 percent above October 1987 prices and 10 percent above year-earlier levels. Nitrogen and phosphate prices will likely show the greatest increase from last fall. Most of the rise in potash prices expected from the anti-dumping suit against Canadian potash producers has already occurred.

Last August, the Department of Commerce issued a preliminary finding that Canadian potash had been sold in the United States at 9 to 85 percent of fair market value. Duties imposed to compensate for this price differential resulted in wholesale price increases by both Canadian and U.S. producers. By October 1987, the price of potassium chloride paid by farmers increased 17 percent from April to $135 per ton. However, during early January 1988, the Department of Commerce negotiated an agreement with Canadian potash producers to end the anti-dumping case. The agreement will provide some price protection to U.S. potash producers, but prices to farmers will likely remain substantially above year-earlier levels. Further potash price increases could be limited, however, as market supplies appear to be ample.

Table 2--U.S. production of fertilizer nutrients for years ending June 30

Material	1986	1987 1/	Annual change
	Thousand tons		Percent
Nitrogenous fertilizers: 2/			
Anhydrous ammonia 3/	15,637	15,160	-3
Ammonium nitrate, solid	2,059	1,907	-7
Urea 3/	6,417	6,724	5
Nitrogen solutions	2,533	2,488	-2
Phosphate fertilizers: 4/			
Normal and enriched superphosphate	58	138	140
Triple superphosphate	1,067	1,106	4
Diammonium phosphate	4,285	4,601	7
Monammonium phosphate	827	790	-4
Total 5/	6,236	6,635	6
Wet-process phosphoric acid 6/	9,068	9,441	4
Muriate of potash: 7/			
United States	1,210	1,344	11
Canada	7,187	7,751	8

1/ Preliminary. 2/ Total not listed because nitrogen solutions are in 1,000 tons of N, while other nitrogen products are in 1,000 tons of material. 3/ Includes material for nonfertilizer use. 4/ Reported in 1,000 tons P_2O_5. 5/ Does not include ammonium phosphates other than diammonium and monammonium phosphate. 6/ Includes merchant acid. 7/ Reported in 1,000 tons of K_2O.

Source: (1,7).

After falling by 21 percent from May 1984 to October 1986, fertilizer prices paid by farmers increased 1 percent by April 1987. Prices increased an additional 3 percent between April and October 1987, primarily because of higher phosphate and potash

Table 3--Average U.S. farm prices for selected fertilizer materials 1/

Year		Anhydrous ammonia (82%)	Triple superphosphate (44-46%)	Diammonium phosphate (18-46-0%)	Potash (60%)	Mixed fertilizer (6-24-24%)
				Dollars per ton		
1984:	May	280	231	271	147	217
1985:	May	252	203	240	128	192
	October	237	195	229	113	182
	December	233	192	224	109	177
1986:	April	225	190	224	111	179
	October	174	182	205	107	173
1987:	April	187	194	220	115	176
	October	180	206	231	135	183

1/ Based on a survey of fertilizer dealers conducted by the National Agricultural Statistics Service, USDA.

Table 4--U.S. imports of selected fertilizer materials for years ending June 30

Material	1985	1986	1987	1988 1/
		Thousand tons		
Nitrogen:				
Anhydrous ammonia	2,956	2,815	2,449	1,212
Urea	1,990	3,105	3,020	586
Ammonium nitrate	542	601	440	66
Ammonium sulfate	370	343	315	67
Sodium nitrate	147	128	97	26
Calcium nitrate	155	128	153	44
Nitrogen solutions	197	284	517	125
Other	253	147	171	27
Total	6,610	7,551	7,162	2,153
Phosphate:				
Ammonium phosphates	201	152	142	55
Crude phosphates	11	349	533	226
Phosphoric acid 2/	1	*	1	*
Normal and triple superphosphate	7	2	27	29
Other	2	2	2	*
Total	222	505	705	310
Potash:				
Potassium chloride	8,893	7,907	7,066	2,591
Potassium sulfate	68	53	54	22
Potassium nitrate 3/	75	79	46	16
Total	9,036	8,039	7,166	2,629
Mixed fertilizers	152	126	120	13
Total	16,020	16,221	15,153	5,105
		Billion dollars		
Total value 4/	1.51	1.29	1.02	0.38

* = Less than 1,000 tons.

1/ Preliminary data for July-November 1987. 2/ Includes all forms of phosphoric acid. 3/ Includes potassium sodium nitrate. 4/ Value by fertilizer material in appendix table 1.

Source: (6).

prices. Potash and diammonium phosphate prices increased 17 and 5 percent, respectively, from April to October, while anhydrous ammonia prices fell almost 4 percent (table 3).

U.S. Fertilizer Trade

Fertilizer import volume in 1986/87 fell about 7 percent from a year earlier, while value fell around 20 percent (table 4). Imports totaled approximately 15.2 million tons valued at $1.02 billion. Canada provided a substantial share of U.S. nitrogen imports and almost all potash imports. Exports of 23.7 million tons were up about 9 percent from 1985/86 (table 5). Asian countries were the largest markets, followed by Canada and Latin America. Japan, for example, received about 8 percent of all U.S. fertilizer exports while Canada received over 20 percent of phosphate rock exports.

Nitrogen

Reduced U.S. crop acreage and depressed prices discouraged nitrogen imports and encouraged exports. Nitrogen imports in 1986/87 (material basis) decreased about 5 percent while exports increased 30 percent.

A 13-percent decrease in anhydrous ammonia imports and a 3-percent decrease in urea imports accounted for most of the decrease in nitrogen fertilizer imports. Imports of urea from Eastern Europe declined due to anti-dumping rulings that resulted in

Table 5--U.S. exports of selected fertilizer materials for years ending June 30

Material	1985	1986	1987	1988 1/
		Thousand tons		
Nitrogen:				
Anhydrous ammonia	1,069	759	1,062	482
Urea	1,388	718	790	551
Ammonium nitrate	34	188	258	57
Ammonium sulfate	829	721	1,031	410
Sodium nitrate	21	19	12	5
Nitrogen solutions	7	114	123	551
Other	58	62	78	19
Total	3,406	2,581	3,354	2,075
Processed phosphate:				
Normal superphosphate	4	4	4	1
Triple superphosphate	1,556	1,308	1,724	594
Diammonium phosphate	7,896	4,287	5,918	2,919
Other ammonium phosphate	544	542	583	312
Phosphoric acid 2/	1,515	594	921	149
Total	11,515	6,735	9,150	3,974
Phosphate rock 3/	11,649	11,294	9,933	4,039
Potash:				
Potassium chloride	795	602	797	262
Potassium sulfate	88	135	220	163
Other	233	241	213	87
Total	1,116	978	1,230	512
Mixed fertilizers	99	70	32	25
Total	27,785	21,658	23,699	10,625
		Billion dollars		
Total value	2.9	4/	4/	4/

1/ Preliminary data for July-November 1987. 2/ Prior to 1986, phosphoric acid exports included both wet-process phosphoric acid and superphosphoric acid. Superphosphoric acid reports were discontinued after June 1985; 1986 and 1987 data are no longer comparable with 1985 and earlier years. 3/ Effective January 1984, phosphate rock exports include a small tonnage of miscellaneous fertilizers. 4/ Declared value of exports by selected materials are not reported after June 1985.

Source: (5).

higher import prices. Urea imports declined to 3.0 million tons while anhydrous ammonia imports fell to 2.4 million tons. Increased imports of calcium nitrate, nitrogen solutions, and other nitrogen materials (20, 82, and 16 percent, respectively) were partially offsetting. Urea represented 42 percent of all nitrogen material imports, followed by anhydrous ammonia (34 percent), nitrogen solutions (7 percent), and ammonium nitrate plus ammonium sulfate (11 percent).

Canada remained the most important supplier of nitrogen fertilizers, providing about 42 percent of U.S. import tonnage. The Soviet Union ranked second, accounting for 15 percent, while Trinidad-Tobago, Romania, and the Netherlands provided 7, 3, and 3 percent, respectively. Canada's share of U.S. anhydrous ammonia imports increased from 43 to 48 percent, while the Soviet Union's share declined from 29 to 28 percent. Trinidad-Tobago's share also declined from 17 to 15 percent as did Mexico's share, dropping from 5 to 1 percent. Canada was also the major source of imported urea, supplying about 41 percent of the 3.0 million tons imported by the United States in 1986/87. Another 20 percent came from the Netherlands and the Soviet Union.

The International Trade Commission (ITC) instituted preliminary anti-dumping investigations concerning urea imports from East Germany, Romania, and the Soviet Union following a producers' petition filed in July 1986. In December 1986, the Department of Commerce tentatively determined that Eastern European producers were dumping urea in the U.S. market and required importers of urea from Eastern Europe to post bonds, thus raising import prices from these countries. Consequently, urea imports from Eastern Europe declined during 1986/87 since they were no longer competitive in the U.S. market. However, urea imports from Canada increased more than 20 percent from the previous year.

Anhydrous ammonia, urea, and diammonium phosphate exports increased 40, 10, and 38 percent, respectively, in 1986/87, accounting for most of the increase in nitrogen exports (table 5). Anhydrous ammonia exports accounted for 32 percent of the 3.4 million tons of nitrogen materials exported, while ammonium sulfate represented 31 percent, urea exports represented 24 percent, and ammonium nitrate 8 percent.

In 1986/87, the Republic of Korea, Spain, and Tunisia were the largest customers for U.S. anhydrous ammonia, while Brazil was the largest customer for U.S. ammonium sulfate, purchasing 54 percent of the 1 million tons exported. China, Chile, and Canada purchased the most urea, representing 31, 19, and 12 percent, respectively, of the total exported.

Phosphate

U.S. phosphate fertilizer exports in 1986/87 recovered somewhat from adverse marketing conditions the previous year. Exports increased over a third from the previous year to 9.2 million material tons, but were still below the record volume in

1984/85. Brazil and India purchased 60 percent more phosphoric acid than the previous year. Canada purchased 120 percent and Brazil 300 percent more concentrated superphosphate than in 1985/86. Diammonium phosphate exports accounted for the largest share (65 percent) of the 9.2 million tons of processed phosphate exported. Mainland China increased purchases by 380 percent over 1985/86 and was the largest customer for diammonium phosphate, representing 20 percent of the 5.9 million tons exported. Belgium-Luxembourg and Pakistan accounted for an additional 12 percent each. Canada purchased 90 percent more monoammonium phosphate.

China was the largest purchaser of U.S. phosphate fertilizer in 1986/87, accounting for 13 percent of U.S. phosphate exports. Other important customers were Canada, with 11 percent, and India, Belgium-Luxembourg, and Pakistan, each with 8 percent. Although data on exports of superphosphoric acid to the Soviet Union are not available, the Soviets are also a large customer for U.S. phosphate fertilizer.

U.S. phosphate rock exports declined about 12 percent to 9.9 million tons, continuing a trend toward shipping processed phosphate fertilizer rather than rock. Foreign demand for U.S. phosphate rock has declined in the past few years. Other exporting countries have freight advantages in competitive markets, and their phosphate rock has a higher ore content than U.S. rock.

Potash

U.S. potassium chloride imports declined about 11 percent in 1986/87 to 7.1 million tons in response to the decline in domestic consumption. Potassium chloride accounted for almost all potash imports, with Canada providing 95 percent of the total (table 4). Israel was the only other significant supplier, with 3 percent.

U.S. exports of potassium fertilizer materials increased about 26 percent in 1986/87. Approximately 1.2 million tons were shipped, with potassium chloride accounting for 65 percent of the total (table 5). Potassium sulfate, which increased 63 percent and accounted for 18 percent of potassium materials, has continued to gain some importance as an export item.

Fertilizer Use Estimates

In the year ending June 30, 1987, about 43 million tons of fertilizer materials were used in the United States and Puerto Rico, 2 percent less than in 1985/86 as planted acreage fell 7 percent (table 6). In terms of total plant nutrients, use also declined by about 2 percent to 19.2 million tons. Nitrogen use declined less than 2 percent to 10.3 million tons, phosphate use fell 4 percent to 4.0 million tons, and potash consumption, at 4.9 million tons, also declined 4 percent.

While planted corn acreage declined by 14 percent in 1987, per-acre fertilizer use on corn averaged close to year-earlier levels, even though the least fertilized acres are typically removed from production under Government programs (table 7). Per-acre use of nitrogen and phosphate on corn was unchanged from 1986, while potash use increased. Fertilizer nutrient applications on cotton, soybeans, and wheat were mixed. Fertilizer application rates in 1987/88 are expected to remain close to last year's levels for major crops, as declines in loan rates and target prices and higher fertilizer prices are offset by declining incidences of farm financial stress and, in some cases, higher commodity prices.

Corn for Grain

Fertilizer was applied to 96 percent of corn acres in 1986/87 as the proportion of acres fertilized for each of the three nutrients changed little. Application rates of nitrogen and phosphate remained unchanged from a year earlier at 132 and 61 pounds, respectively, while the rate for potash increased from 80 to 85 pounds.

Cotton

About 76 percent of cotton acreage received some fertilizer in 1986/87, down 4 percent from a year earlier as the proportion of acres fertilized with each plant nutrient declined. Average nitrogen use increased, however, as the decline in acres fertilized was offset by a 5-pound increase in the average application rate which rose to 82 pounds.

Table 6--U.S. fertilizer consumption 1/

Year ending June 30 2/	Total fertilizer materials	Primary nutrient use				Share of 1977 total nutrient use
		N	P_2O_5	K_2O	Total 3/	
		Million tons				Percent
1977	51.6	10.6	5.6	5.8	22.1	100
1978	47.5	10.0	5.1	5.5	20.6	93
1979	51.5	10.7	5.6	6.2	22.6	102
1980	52.8	11.4	5.4	6.2	23.1	104
1981	54.0	11.9	5.4	6.3	23.7	107
1982	48.7	11.0	4.8	5.6	21.4	97
1983	41.8	9.1	4.1	4.8	18.1	82
1984	50.1	11.1	4.9	5.8	21.8	99
1985	49.1	11.5	4.7	5.6	21.7	98
1986	44.1	10.4	4.2	5.1	19.7	89
1987	43.2	10.3	4.0	4.9	19.2	87

1/ Includes Puerto Rico. Detailed State data shown in appendix table 2. 2/ Fertilizer use estimates for 1977 to 1984 are based on USDA data, while 1985 through 1987 are TVA estimates. 3/ Totals may not add due to rounding.

Table 7--Fertilizer use on selected U.S. field crops 1/

Crop, year	Acres receiving				Application rates		
	Any fertilizer	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	Percent				Pounds per acre		
Corn for grain:							
1983	96	97	88	83	137	64	85
1984	97	97	87	82	138	65	87
1985	98	97	86	79	140	60	84
1986	96	95	84	76	132	61	80
1987	96	96	83	75	132	61	85
Cotton:							
1983	68	68	44	30	81	45	52
1984	77	76	48	32	81	48	53
1985	76	76	50	34	80	46	52
1986	80	80	50	39	77	44	50
1987	76	76	47	33	82	44	45
Soybeans:							
1983	33	20	30	32	18	45	70
1984	34	20	30	32	17	46	72
1985	32	17	28	30	15	43	72
1986	33	18	29	31	15	43	71
1987	30	15	25	28	20	47	75
All wheat:							
1983	73	72	48	20	60	39	48
1984	76	76	49	17	62	37	46
1985	77	77	48	16	60	35	36
1986	79	79	48	19	60	36	44
1987	80	80	50	15	62	35	43
Sorghum 2/:							
1987	85	85	47	17	79	37	40

1/ Detail for selected States by crop are found in appendix tables 3 through 7. 2/ Data for sorghum not available for 1983-86.

Potash application rates declined from 50 to 45 pounds, while the rate of phosphate applied remained at 44 pounds.

Sorghum

Some fertilizer was applied to 85 percent of sorghum acres in 1986/87. The proportion of acres receiving nitrogen, phosphate, and potash stood at 85, 47, and 17 percent, respectively. Application rates were highest for nitrogen at 79 pounds, followed by 40 pounds for potash, and 37 pounds for phosphate.

Soybeans

The proportion of soybean acres fertilized declined from 33 to 30 percent, with nitrogen falling to 15 percent, phosphate to 25, and potash to 28. Average application rates for all three nutrients increased, however, from 15 to 20 pounds for nitrogen, 43 to 47 pounds for phosphate, and 71 to 75 pounds for potash.

Wheat

The share of wheat acres fertilized increased for the fifth consecutive year to 80 percent of acres treated. The share receiving nitrogen and phosphate increased to 80 and 50 percent, respectively, while the share receiving potash fell from 19 to 15 percent. Nitrogen application rates also increased 2 pounds an acre to 62 pounds, while phosphate and potash rates each fell a pound.

While total U.S. fertilizer use declined, regional consumption was mixed in 1986/87, increasing in five regions and decreasing in five regions. Plant nutrient use increased from 1 percent in the Lake States to 10 percent in the Mountain region, while regional decreases ranged from 1 to 13 percent (table 8). Nitrogen use increased in five regions, fell in three, and remained stable in two (table 9). Phosphate and potash use dropped the most in the Delta States and increased the most in the Mountain region.

The proportion of fertilizers applied as multiple nutrient materials declined to 41 percent, while the proportion applied as a single nutrient increased to 59 percent (table 10).

Table 8--Regional plant nutrient consumption for year ending June 30 1/

Region	1986	1987	Annual changes
	Thousand tons		Percent
Northeast	738	716	-3
Lake States	2,438	2,468	1
Corn Belt	6,661	6,165	-7
Northern Plains	2,352	2,396	2
Appalachia	1,531	1,489	-3
Southeast	1,488	1,481	-1
Delta States	945	826	-13
Southern Plains	1,405	1,460	4
Mountain	819	905	10
Pacific 2/	1,247	1,277	2
U.S. total 3/	19,624	19,183	-2

1/ Includes N, P_2O_5, and K_2O. Totals may not add due to rounding. 2/ Includes Alaska and Hawaii. 3/ Excludes Puerto Rico. Detailed State data shown in appendix table 2.

Source: (2).

World Fertilizer Review and Prospects

World plant nutrient production fell in 1985/86, but is projected to have expanded in 1986/87, while use declined slightly in 1985/86 and is projected to have increased in 1986/87. Fertilizer production and consumption fell slightly in the developed market economies but increased in the developing market economies.

Supplies

World plant nutrient supplies in 1985/86 decreased over 2 percent to 129.0 million metric tons (table 11). Nitrogen supplies fell less than 2 percent to 70.0 million tons, while phosphate supplies decreased 4 percent to 33.3 million metric tons. Potash supplies fell to 25.7 million metric tons, or about 2 percent.

Due to greater production, world plant nutrient supplies likely rose about 9 percent in 1986/87. Although U.S. planted acreage will continue to be constrained due to financially attractive acreage control programs, planted acreage outside the United States is expected to expand, encouraging an expansion of non-U.S. fertilizer production and consumption.

Consumption

World fertilizer consumption in 1985/86 decreased about 2 percent from a year earlier to about 128.7 million metric nutrient tons (table 11). Nitrogen consumption decreased by less than 1 percent to about 70 million metric tons, while phosphate consumption decreased 3 percent to 33.1 million metric tons. Potash consumption decreased only 1 percent to 25.6 million metric tons.

World plant nutrient use rose an estimated 2 percent in 1986/87, due to increased demand in the developing market economies of Latin America and Asia.

Projections for 1987-92

According to 1987 FAO/World Bank forecasts, world nitrogen, phosphate, and potash fertilizer consumption is expected to grow 16, 16, and 12 percent, respectively, during 1987-92 (table 12). Fertilizer

Table 9--Regional plant nutrient use for year ending June 30 1/

Region	1986	1987	Annual changes
	Thousand tons		Percent
Nitrogen:			
Northeast	278	287	3
Lake States	1,059	1,063	0
Corn Belt	3,116	2,889	-7
Northern Plains	1,739	1,797	3
Appalachia	621	603	-3
Southeast	659	662	0
Delta States	557	511	-8
Southern Plains	965	1,022	6
Mountain	557	622	12
Pacific 2/	860	881	2
U.S. total 3/	10,412	10,336	-1
Phosphate:			
Northeast	196	183	-7
Lake States	509	493	-3
Corn Belt	1,380	1,256	-9
Northern Plains	498	487	-2
Appalachia	378	378	-0
Southeast	288	294	2
Delta States	164	132	-19
Southern Plains	298	305	2
Mountain	213	229	7
Pacific 2/	250	252	1
U.S. total 3/	4,173	4,008	-4
Potash:			
Northeast	263	247	-6
Lake States	871	912	5
Corn Belt	2,165	2,020	-7
Northern Plains	115	112	-3
Appalachia	532	508	-4
Southeast	542	525	-3
Delta States	225	184	-18
Southern Plains	142	133	-6
Mountain	49	54	11
Pacific 2/	137	144	5
U.S. total 3/	5,040	4,840	-4

1/ Totals may not add due to rounding. 2/ Includes Alaska and Hawaii. 3/ Excludes Puerto Rico. Detailed State data shown in appendix table 2.

Source: (2).

Table 10--Average annual U.S. fertilizer use 1/

Year ending June 30 4/	Multiple nutrient 2/		Single nutrient 3/	
	Quantity	Share of total	Quantity	Share of total
	Million tons	Percent	Million tons	Percent
1977	24.1	47	27.5	53
1978	22.1	47	25.4	53
1979	23.7	46	27.7	54
1980	23.3	44	29.5	56
1981	23.5	44	30.5	56
1982	20.9	43	27.8	57
1983	18.4	44	23.5	56
1984	21.2	42	28.9	58
1985	20.6	44	26.7	56
1986	17.8	42	24.7	58
1987	17.3	41	24.4	59

1/ Includes Puerto Rico. 2/ Fertilizer materials that contain more than one primary nutrient. 3/ Materials that contain a single nutrient. 4/ Fertilizer use estimates for 1976 to 1984 are based on USDA data, while 1985 through 1987 are TVA estimates.

Source: (2).

Table 11--World plant nutrient supply and consumption for years ending June 30

Plant nutrient	1985	1986	1987 1/
	Million metric tons		
Available supply: 2/			
Nitrogen	71.2	70.0	74.2
Phosphate	34.6	33.3	36.8
Potash	26.1	25.7	30.3
Total 3/	131.9	129.0	141.3
Consumption:			
Nitrogen	70.5	70.0	71.2
Phosphate	33.9	33.1	33.9
Potash	25.9	25.6	26.1
Total 3/	130.3	128.7	131.2

1/ Projected. 2/ Production less industrial uses and losses in transportation, storage, and handling. 3/ Totals may not add due to rounding.

Source: (3, 4).

Table 12--Projected 1987-92 change in world fertilizer supply and consumption

World regions	Nitrogen	Phosphate	Potash
	Percent increase		
Supply potential:			
Developed market economies	3	8	6
Developing market economies	28	29	26
Eastern Europe and the Soviet Union	4	9	10
Centrally planned countries of Asia	9	26	134
Total	10	14	8
Consumption:			
Developed market economies	4	6	5
Developing market economies	30	29	29
Eastern Europe and the Soviet Union	15	7	10
Centrally planned countries of Asia	17	48	56
Total	16	16	12

1/ Detail in appendix table 8.

Source: (3, 4).

production and use are projected to grow the fastest in the developing countries and centrally planned economies of Asia. In developed countries, consumption is expected to increase 4 to 6 percent by 1992, down from earlier projections of over 10-percent growth. Declines in the United States due to acreage set-aside programs and stable demand in Western Europe will slow the growth in world fertilizer use and affect nitrogen and phosphate production rates. Also, increased North American potash exports will support growth in potash production in the developed countries, while a decline in Eastern European and Soviet Union potash exports could result in a smaller increase in production in those areas.

In the developing countries, the supply potential of the three plant nutrients will be increased from 26 to 29 percent by 1992, while consumption will be up about 30 percent. The rapid increase is attributable to the goals of many developing countries to move toward self sufficiency in food and fertilizer production.

Nitrogen and phosphate production in the developed countries is expected to grow 3 and 8 percent, respectively, while potash production is expected to be up 6 percent. Most of the increase will come from greater Canadian potash and nitrogen production. Israel is also expected to increase potash production, while France, the Netherlands, and the United Kingdom are expected to increase nitrogen production. Increased phosphate fertilizer production in the United States will depend heavily on phosphate export potential.

Among Asian and Eastern European centrally planned countries, greater nitrogen production capacity will be limited mostly to those plants built in China.

Among developing countries, nitrogen production is expected to increase near natural gas reserves located in India, Indonesia, Saudi Arabia, Mexico, and Trinidad Tobago.

During 1987 92, world phosphate fertilizer production will center primarily in the United States, the Soviet Union, and Morocco. About a third of the phosphoric acid supply capability will be in the United States. Another 17 percent will be located in the Soviet Union, and about 10 percent in Morocco. Also, increased phosphate production in India, China, Mexico, Tunisia, and Brazil will add to world supplies.

World potash production potential is expected to increase about 8 percent. Canada will add the most capacity, with other additions in Israel, Jordan, Brazil, Thailand, and China. Projected regional shares of world fertilizer supply and demand indicate a continued shift in production and use away from the developed countries to the developing countries. The centrally planned countries' share of world fertilizer production will remain relatively constant at 40 percent through 1992. Their share of nutrient consumption will remain about the same at 39 percent (table 13).

Western Europe, Asia, and Africa are projected to be nitrogen-deficit areas through 1992. Latin America, the Near East, Eastern Europe, and the Soviet Union will be surplus areas, as countries with plentiful natural gas resources produce nitrogen fertilizer for export.

North America will be a marginally surplus area due to increased Canadian production and less optimistic forecasts of nitrogen fertilizer use in the United States.

Table 13--Projected regional shares of world fertilizer supply potential and demand 1/

World regions	Nitrogen		Phosphate		Potash	
	1987	1992	1987	1992	1987	1992
	Percent					
Supply potential:						
Developed market economies	29.9	28.2	47.7	45.2	57.8	56.5
North America	14.5	13.6	25.0	25.3	36.3	35.3
Western Europe	13.9	13.1	14.6	12.7	17.6	15.9
Oceania	0.4	0.6	3.6	3.3	0.0	0.0
Other countries	1.1	0.9	4.5	3.9	4.0	5.2
Developing market economies	21.7	25.2	20.4	23.1	2.3	2.7
Africa	0.3	0.7	7.8	9.5	0.0	0.0
Latin America	5.5	6.0	4.5	5.2	0.1	0.3
Asia	15.9	18.5	8.1	8.5	2.3	2.4
Eastern Europe and the Soviet Union	30.8	29.1	25.0	24.0	39.8	40.6
Centrally planned countries of Asia	17.6	17.5	6.9	7.7	0.1	0.2
Consumption:						
Developed market economies	31.3	28.2	33.9	31.0	42.3	39.6
North America	14.1	12.9	12.4	11.5	18.0	17.4
Western Europe	15.1	13.4	15.2	13.2	20.3	18.4
Oceania	0.5	0.5	3.1	3.1	1.1	1.1
Other countries	1.6	1.4	3.2	3.2	2.9	2.8
Developing market economies	24.8	27.9	25.6	28.6	15.4	17.7
Africa	1.2	1.3	1.9	2.1	1.3	1.5
Latin America	4.9	5.9	7.7	8.1	6.6	7.7
Asia	18.7	20.7	16.0	18.3	7.5	8.5
Eastern Europe and the Soviet Union	22.7	22.5	31.6	29.1	39.1	38.2
Centrally planned countries of Asia	21.2	21.4	8.9	11.3	3.3	4.5

1/ Forecasts for year ending June 30.

Source: (3).

The availability of nitrogen production capacity relative to projected demand will likely allow sufficient supplies until the end of the decade. World nitrogen fertilizer prices should remain fairly stable through 1990. However, excess production capacity has been reduced, indicating that supplies will not meet demand without price increases.

The developed countries are projected to have a surplus of phosphate fertilizer, while the Soviet Union, Asia, and Eastern Europe will be deficit areas. Africa will have the largest surpluses. Asia is expected to be the greatest deficit area.

Potash supply capability should be adequate into the next decade. The greatest potash surplus is forecast for North America due to increased Canadian production. Eastern Europe and the Soviet Union will also remain major surplus areas. Western Europe, Asia, Africa, and Latin America are projected to be deficit areas.

World Trade Developments

Existing nitrogen trade patterns should continue. Eastern Europe, the Soviet Union, and Romania will continue to supply nitrogen fertilizer to the United States, Western Europe,and Asia. Additional nitrogen fertilizer production in Trinidad-Tobago will be competing for a share of the already crowded North American, West European, and Mediterranean markets. This could put downward pressures on prices. Surplus nitrogen from the Near East will probably move to the Asian markets.

Phosphate production is expected to grow in most regions of the world. U.S. consumption is stabilizing, but world consumption will increase at a faster rate than production, causing the supply-demand balance to tighten. Asia should have the most active trade since these countries are expected to produce only a small share of the phosphate demanded. The African and U.S.

phosphate fertilizer industries will be in competition for this growing market.

Western Europe offers limited scope for increased use of phosphate fertilizer. Phosphate use in Eastern Europe will also stabilize -- distribution systems in Eastern Europe are not effective and limit increased use. Mexico and Brazil, the principal consumers of phosphate fertilizer in Latin America, are scheduled to bring new plants into production.

Canada, East Germany, and the Soviet Union are the major potash exporters. Canada's exports are expected to increase relative to the other major exporters with further penetration of the large Indian and Chinese markets and continued exports to the United States.

World Fertilizer Prices

A significant tightening of world supplies but relatively low demand caused prices of nitrogen products to remain stable during the first half of the 1986/87 fertilizer year. The nitrogen materials market tightened markedly during the second half, however, resulting in higher prices for most products.

Several factors contributed to the rise in nitrogen product prices:

- Increased inventories by fertilizer distributors in anticipation of the spring application season in Europe and the United States.
- Production in both Western and Eastern Europe was affected by severe weather as domestic requirements for gas took priority over industrial customers.
- Middle East suppliers reportedly had virtually no inventories during the second half of the fertilizer year.
- Indonesian availability was restricted due to reduced domestic production.
- Supplies from U.S. and Caribbean producers were committed.
- Large contracts of ammonia sales between the Soviet Union and West Mediterranean and Turkish buyers were concluded, reducing supplies for other purchasers.
- China, Iran, and Pakistan secured significant volumes of urea from Arab Gulf suppliers.
- South American and African markets continued to be the major focus in the sluggish ammonium sulfate market. However, tightening supplies by the United States and Japanese producers resulted in higher prices.

Prices of phosphate fertilizers also remained low during the first half of fertilizer year 1986/87, but rose during the second half. China returned to the phosphate market and the Soviet Union concluded large trade agreements with Tunisia and other North African producers for triple superphosphate.

Potash prices during the first part of the fertilizer year remained low, but improved during the second half due to heavy buying by Chinese and other Southeast Asian markets. Malaysia and Indonesia were also buoyant markets. Canadian shipments to Japan were significantly higher than the previous year.

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PESTICIDES

Demand

Agriculture use of pesticides in 1988 is expected to be similar to or up slightly from 1987. Planted acreage for some field crops, including corn and cotton is expected to be up in 1988 but the final acreage will depend on farmers' participation in commodity programs.

Pesticide use on major field crops could range from 420 to 464 million pounds active ingredients (a.i.)(table 14). In 1987, an estimated 429 million pounds were used, with herbicides totaling 365 million, insecticides 57 million, and fungicides 7 million pounds. Corn and soybean production account for most of the herbicide use while corn and cotton dominate insecticide use. Fungicides are most commonly used in peanut production.

Supplies

The domestic supply of pesticides available for U.S. farm use is expected to be down 14 percent from last year but adequate to meet 1988 crop needs (table 15). Production is expected to be down 6 percent and inventory carryover 16 percent. The increase in exports can be attributed in part to the decline in the value of the dollar.

Domestic herbicide supplies for 1988 are projected at 423 million pounds (a.i.), down 21 percent from last year. Manufacturers are expected to reduce production by 6 percent, and during the past year inventories have been drawn down 23 percent. Herbicide exports are expected to jump 17 percent in 1988. With herbicide consumption projected to range from 356 to 394 million pounds, supplies will be tighter than in previous years.

Insecticide supplies are expected to be down 8 percent in 1988. Insecticide production is expected to be down but inventory carryover and imports are above 1987 levels. Exports are likely to be up in 1988 but not as much as herbicides and fungicides. Fungicide supplies are projected to be up 22 percent because of increased production and imports and declining exports.

Overall domestic plant capacity utilization is projected at 61 percent for 1988, down 1 percentage point from 1987 (table 16). Over the past 3 years, plant utilization has declined as manufacturers have reduced pesticide production because of the decrease in crop acres planted under the 1985 Food Security Act.

Prices

Pesticide prices quoted by manufacturers for the 1988 crop season are projected to be up 1 to 2 percent from last year (table 17). This increase results from a tightening of supplies because of projected decreases in production and inventories going into the 1988 growing season. During the past 2 years,

Table 14 -Estimated pesticide demand by U.S. field crop farmers

Crop	Oct 1 1987 planted acreage	Projected 1988 use		
		Herbicides	Insecticides	Fungicides
	Million	Million pounds (active ingredients)		
Row:				
Corn	66.0	192 - 212	23.8 - 26.3	.06
Cotton	10.4	17 - 19	16.6 - 18.4	.18
Grain sorghum	11.8	11 - 12	1.8 - 2.0	0.00
Peanuts	1.5	5 - 6	1.1 - 1.2	5.46
Soybeans	58.7	99 - 109	8.7 - 9.6	.06
Tobacco	.6	1 - 2	2.2 - 2.4	.30
Total	149.0	325 - 360	54.2 - 59.9	6.12
Small grains:				
Barley and oats	29.0	7 - 8	.2 - .3	0.00
Rice	2.3	11 - 12	.5 - .6	.07
Wheat	65.8	13 - 14	1.7 - 1.9	.73
Total	97.1	31 - 34	2.4 - 2.8	.80
Total	246.1	356 - 394	56.6 - 62.7	6.92

herbicide and insecticide prices in the aggregate have been stable at the retail level. The herbicide price in 1986 and 1987 was constant at $4.05 per pound (a.i.) while the insecticide price declined slightly from $10.27 to $10.25 per pound.

1987 Pesticide Use

Corn for Grain

Herbicides were used on 96 percent of the surveyed corn acreage in 1987, similar to the 2 previous years (table 18). South Dakota farmers treated the fewest acres for weed control at 79 percent.

Insecticides were used on 41 percent of the corn acreage in 1987, the same as the previous year but down from 45 percent in 1985. Insecticide use was greatest in Nebraska where 60 percent of the corn acreage was treated. In contrast, Minnesota and South Dakota farmers treated only 22 and 13 percent of their corn acreage, respectively. In Nebraska, corn earworm larvae can be a problem because about two-thirds of the corn acreage is irrigated and a high proportion is planted to corn year after year. In Minnesota and South Dakota, more of the corn acreage is rotated with other crops, including small grains, which reduces insect problems.

Table 15--U.S. pesticide production, inventories, exports, and domestic availability

Item	Quantity (active ingredients) 1/		
	1987	Projected 1988	Projected change, 1987-1988
	Million pounds		Percent
Herbicides:			
Production	421	394	-6
Carryover	199	153	-23
Imports	34	33	-3
Exports	134	157	17
Domestic availability	520	423	-21
Insecticides:			
Production	169	155	-8
Carryover	57	62	9
Imports	7	9	29
Exports	68	74	9
Domestic availability	165	152	-8
Fungicides:			
Production	52	57	10
Carryover	6	5	-17
Imports	3	4	33
Exports	25	22	-12
Domestic availability	36	44	22
All pesticides:			
Production	642	606	-6
Carryover	262	220	-16
Imports	44	46	5
Exports	227	253	11
Domestic availability	721	619	-14

1/ Production for surveyed manufacturers only. These firms produce a major portion of all U.S. farm pesticides.

Source: USDA survey of basic pesticide manufacturers, December 1987.

Table 16--U.S. pesticide production capacity utilization rates

Year	Herbicides	Insecticides	Fungicides	All pesticides
	Percent			
1979	74	85	84	80
1980	77	79	84	78
1981	74	72	68	73
1982	84	68	70	80
1983	66	33	71	54
1984	67	29	73	52
1985	62	56	66	61
1986	64	63	61	65
1987	63	61	59	62
1988 1/	62	60	62	61

1/ Projected.

Source: USDA annual survey of basic pesticide manufacturers, December 1987.

Table 17--Pesticide price changes

Item	1985/86 1/	1986/87 1/	Projected 1987/88 2/
	Percent		
Herbicides	*	*	2
Insecticides	-2	*	1
Fungicides	na	na	1

* -- Less than 1 percent.
na -- not available.

1/ April prices paid by farmers. 2/ Quoted manufacturer prices.

Source: USDA annual survey of basic pesticide producers, December 1987.

Table 18--Pesticide use on selected row crops, 1987 1/

Crop & State	Acres treated with	
	Herbicides	Insecticides
	Percent	
Corn:		
Illinois	98	44
Indiana	98	43
Iowa	97	43
Michigan	94	38
Minnesota	94	22
Missouri	96	40
Nebraska	96	60
Ohio	99	38
South Dakota	79	13
Wisconsin	95	50
1987 average	96	41
1986 average	96	41
1985 average	96	45
Soybeans:		
Alabama	93	2
Arkansas	92	2
Georgia	88	9
Illinois	98	2
Indiana	96	nr
Iowa	99	2
Kentucky	89	1
Louisiana	94	9
Minnesota	91	nr
Mississippi	95	8
Missouri	93	4
Nebraska	100	3
North Carolina	79	23
Ohio	96	nr
Tennessee	96	nr
1987 average	95	3
1986 average	96	4
1985 average	95	7
Cotton:		
Arizona	95	77
Arkansas	99	81
California	80	79
Louisiana	100	93
Mississippi	98	95
Texas	95	39
1987 average	94	61
Sorghum:		
Kansas	84	11
Missouri	89	7
Nebraska	87	10
Texas	75	22
1987 average	82	17

nr = none reported.
1/ States in survey harvested 47.8 million acres of corn (80 percent of U.S. total) in 1987, 49.5 million acres of soybeans (87 percent of U.S. total) in 1987, 8 million acres of cotton (80 percent of U.S. total) in 1987, and 8.1 million acres of sorghum (77 percent of U.S. total) in 1987.

In the 10 surveyed States, herbicides were applied to 46 million corn acres (table 19). On average 1.2 herbicide applications were made during the crop season.

Atrazine + alachlor was the most commonly used herbicide treatment, and was applied to 26 percent of the treated acreage. Both active ingredients control a large number of broadleaf and grass weeds, but when applied in combination the control spectrum is broadened. Atrazine was also used extensively in combination with metolachlor. In addition, atrazine was used alone more often than any other herbicide, with applications to 12 percent of the corn acres.

Insecticides were generally applied at planting for corn rootworm larvae control. However, insecticides were also used to control cutworms and European cornborers. Terbufos (34 percent) was the most commonly used insecticide, followed by chlorpyrifos (27 percent).

Soybeans

In 1987, 95 percent of the soybean acreage in the surveyed States was treated with herbicides (table 18). North Carolina had the fewest acres treated at 79 percent. Insecticides were used on 3 percent of the soybean acreage, similar to 1986.

Herbicide data for soybeans are divided into the northern and southern producing regions. Because of differences in growing conditions and weed problems, the herbicide materials used and number of applications vary between the two regions.

In the northern region, herbicides were applied to 36 million acres in 1987 with an average of 1.3 treatments per acre (table 20). Most of the acreage is treated with a preplant of preemergence material. Trifluralin was the

most commonly used soybean herbicide in 1987. It is applied preplant and controls many broadleaf and grass weeds. Bentazon was second in importance and is applied postemergence for broadleaf weed control. Farmers in the region used several tank-mix herbicide treatments without any one being clearly dominant. However, of the eight tank-mixes listed metribuzin was included in four. Metribuzin is added to the mixtures for cocklebur and velvetleaf control.

In the southern soybean region, herbicides were applied to 11 million acres in 1987 (table 21). Treatments average 1.6 per acre but ranged from 1.2 in North Carolina to 2.1 in Mississippi. In the Delta States, a large proportion of the soybean acreage receives 1 to 3 postemergence herbicide applications because of heavy weed pressure throughout the growing season.

Trifluralin was the most commonly used herbicide, with applications to 30 percent of the acreage in 1987. Imazaquin, registered in 1986, was used on 14 percent of the soybean acreage and tank-mixed with pendimethalin and trifluralin on another 17 percent. Imazaquin can be applied preplant, preemergence and postemergence.

Table 19--Selected herbicides and insecticides used in corn production, 1987

Item	IL	IN	IA	MI	MN	MO	NE	OH	SD	WI	Area
						Thousand					
Acres treated with herbicides	9046	4671	9708	1836	4693	2061	5954	2963	2121	2706	45761
Active ingredients:						Percent					
Single materials --											
Alachlor	7	2	10	3	20	2	8	8	28	3	9
Atrazine	10	11	6	16	10	26	20	6	4	24	12
Cyanazine	2	nr	3	6	5	3	5	2	5	3	3
Dicamba	4	3	8	7	13	nr	2	4	11	1	5
Metolachlor	4	2	18	3	11	1	4	2	6	2	7
2,4-D	6	4	8	3	13	4	7	4	14	1	8
Other	9	4	17	3	30	14	8	3	26	3	14
Tank mixes -											
Atrazine + alachlor	22	28	16	31	7	27	22	22	3	26	26
Atrazine + butylate	10	13	1	nr	nr	nr	4	4	nr	2	4
Atrazine + cyanazine	7	3	8	4	1	9	4	6	1	4	7
Atrazine + metolachlor	17	17	10	18	2	13	10	18	5	8	14
Atrazine + others	11	12	16	11	7	7	7	17	3	12	12
Alachlor + cyanazine	1	2	4	nr	7	1	3	3	2	8	3
Dicamba + 2,4-D	1	nr	11	2	5	nr	2	4	5	1	4
Other	6	8	7	9	19	3	4	9	4	7	7
						Number					
Acre-treatments	1.2	1.1	1.4	1.2	1.4	1.1	1.1	1.1	1.2	1.1	1.2
						Thousand					
Acres treated with insecticides	4080	2047	4293	738	1089	853	3745	1134	364	1425	19768
Active ingredients:						Percent					
Carbofuran	5	8	3	5	19	7	16	13	29	12	9
Chlorpyrifos	39	19	33	28	8	38	19	21	12	19	27
Fonofos	11	26	20	18	10	2	8	28	18	19	16
Terbufos	34	35	34	33	44	13	39	28	29	30	34
Other	15	19	11	21	28	40	32	10	12	19	20
						Number					
Acre-treatments	1.0	1.1	1.0	1.1	1.0	1.0	1.1	1.0	1.0	1.0	1.0

nr = none reported

Table 20 -Selected herbicides used in northern soybean production, 1987

Item	IL	IN	IA	MN	MO	NE	OH	Area
				Thousand				
Acres treated with herbicides	8550	4186	7947	4277	4569	2350	3918	35797
Active ingredients:				Percent				
Single materials -								
Alachlor	5	6	3	7	7	12	4	6
Bentazon	19	9	13	20	7	8	2	13
Chloramben	3	nr	4	8	1	1	5	3
Chlorimuron-ethyl	2	2	1	1	6	nr	nr	2
Ethalfluralin	4	6	2	7	nr	3	1	3
Fluazifop-butyl	3	2	2	1	3	1	2	2
Metolachlor	5	4	1	1	1	nr	2	2
Sethoxydim	4	5	3	3	1	nr	4	3
Trifluralin	12	3	29	42	16	16	2	18
Other	13	15	12	14	20	12	13	14
Tank mixes -								
Trifluralin + metribuzin	5	3	17	14	4	17	2	9
Trifluralin + imazaquin	13	6	2	nr	19	5	2	7
Trifluralin + dimethazone	4	2	6	1	nr	8	nr	3
Alachlor + metribuzin	1	7	5	3	2	1	12	4
Alachlor + linuron	3	5	1	3	2	1	9	3
Metolachlor + metribuzin	2	5	2	2	2	3	7	3
Pendimethalin + imazaquin	12	11	9	nr	9	8	5	8
Pendimethalin + metribuzin	4	1	3	1	1	5	nr	2
Other	25	33	25	24	28	14	43	27
				Number				
Acre-treatments	1.4	1.2	1.4	1.5	1.3	1.2	1.2	1.3

nr = none reported

Acifluorfen + bentazon was used on 12 percent of the soybean acreage. Acifluorfen controls a large number of broadleaf weeds, and the addition of bentazon to the mixture is for control of cocklebur and prickly sida.

Cotton

Herbicides were used on 94 percent of the cotton acreage in the surveyed States in 1987 (table 18). Insecticides were used on 61 percent and ranged from about 95 percent in Louisiana and Mississippi to a low of 39 percent in Texas. Most of the cotton in Texas is grown in the High Plains where insect pressure is low.

On average, farmers applied two herbicide treatments per acre on cotton (table 22). However, treatments were the highest in the Delta and lowest in Texas and the West. Farmers in the Delta applied three herbicide treatments to about 25 percent of the cotton acreage. In Louisiana and Mississippi, 30 to 40 percent of the acreage received four treatments, and 15 percent in each State was treated five times.

Trifluralin (54 percent) was the most commonly used herbicide followed by pendimethalin at 24 percent. Fluometuron was used extensively in the Delta, either preemergence or as a postemergence directed spray. With directed sprays, drop nozzles are used to place the herbicide material in the crop row under the leaf canopy. Tank-mix herbicide treatments were most important in the Delta. MSMA was included in many of the tank mixes and applied as a postemergence directed spray.

Table 21--Selected herbicides used in southern soybean production, 1987

Item	AL	AR	GA	KY	LA	MS	NC	TN	Area
					Thousand				
Acres treated with herbicides	466	3073	704	910	1559	2340	1030	1198	11280
Active ingredients:					Percent				
Single materials--									
Acifluorfen	5	2	3	2	8	13	7	8	6
Alachlor	9	6	8	4	1	1	11	nr	4
Bentazon	9	6	2	4	1	7	2	10	5
Chlorimuron-ethyl	7	2	11	nr	4	nr	3	1	2
Lactofen	6	7	nr	4	2	7	nr	3	4
Fluazifop-butyl	nr	4	nr	11	12	2	nr	5	5
Glyphosate	nr	4	2	nr	8	11	2	2	5
Imazaquin	5	15	8	1	23	15	8	18	14
Metribuzin	10	2	21	nr	5	19	nr	nr	5
Pendimethalin	2	3	14	4	2	12	2	4	5
Sethoxydim	1	2	2	1	9	6	3	2	4
Trifluralin	30	39	24	25	10	34	18	49	30
Other	7	11	15	12	13	13	8	8	11
Tank mixes--									
Acifluorfen + bentazon	10	20	nr	12	4	17	nr	12	12
Imazaquin + pendimethalin	2	10	5	11	15	16	8	9	11
Imazaquin + trifluralin	2	7	nr	4	8	6	2	11	6
Metribuzin + trifluralin	18	9	8	4	4	8	7	4	7
Other	17	13	23	46	41	30	41	18	23
					Number				
Acre-treatments	1.4	1.6	1.4	1.4	1.7	2.1	1.2	1.6	1.6

nr = none reported

Table 22--Selected herbicides used in cotton production, 1987

Item	AZ	AR	CA	LA	MS	TX	Area
				Thousand			
Acres treated with herbicides	293	634	895	600	1070	4047	7538
Active ingredients:				Percent			
Single materials--							
Cyanazine	14	32	9	12	13	nr	7
Fluazifop-butyl	nr	1	2	11	9	1	3
Fluometuron	1	59	1	71	51	2	19
MSMA	3	12	1	15	13	nr	4
Norflurazon	nr	10	nr	8	14	nr	4
Pendimethalin	31	10	40	18	16	26	24
Prometryn	18	11	5	1	19	14	13
Trifluralin	26	21	51	36	21	74	54
Other	10	23	11	26	20	11	15
Tank mixes--							
Cyanazine + MSMA	nr	17	nr	27	29	nr	8
Fluometuron + MSMA	nr	23	nr	25	17	nr	6
Fluometuron + norflurazon	nr	9	nr	9	31	nr	6
Prometryn + MSMA	3	10	nr	26	15	nr	5
Trifluralin + norflurazon	nr	18	nr	17	35	nr	8
Other 2-way mixes	38	55	11	41	36	4	18
3-way tank mixes	nr	15	nr	3	14	nr	4
				Number			
Acre-treatments	1.4	3.3	1.3	3.5	3.5	1.3	2.0

nr = none reported

Table 23--Selected herbicide use in sorghum production, 1987

Item	KS	MO	NE	TX	Area
		Thousand			
Acres treated with herbicides	3113	687	1065	1829	6694
Active ingredients:		Percent			
Single materials--					
Atrazine	34	37	27	16	28
Propazine	6	nr	2	42	15
2,4-D	10	13	26	7	12
Other	3	8	8	1	6
Tank mixes--					
Atrazine + alachlor	9	20	8	4	8
Atrazine + metolachlor	10	11	8	5	9
Atrazine + propachlor	3	13	35	1	10
Atrazine + others	21	1	6	7	12
Other	8	8	3	9	8
		Number			
Acre-treatments	1.0	1.1	1.2	1.1	1.0

nr = none reported

Sorghum

In 1987, herbicides were used on 82 percent of the sorghum acreage in the surveyed States and insecticides on 17 percent (table 18). Important insects include greenbugs, spider mites, chinch bugs, corn earworms, and fall armyworms. Generally, one herbicide treatment was made during the crop season (table 23). Atrazine was the most commonly used herbicide throughout the region, and was applied either alone or tank-mixed with other materials. Important tank-mixes include atrazine + alachlor in Missouri and atrazine + propachlor in Nebraska.

Wheat

Herbicides were used on 48 percent of the winter wheat acreage in the surveyed States in 1987, a 10-percentage point increase from the year before (table 24). In 1987, greater winterkill thinned stands, resulting in greater herbicide use to control invading weeds to prevent additional yield losses. Corn Belt farmers treated only 5 to 10 percent of their winter wheat acreage with herbicides, while producers in Idaho, Montana, Oregon, and Washington treated 90 percent or more. In the Pacific Northwest, winter annual broadleaf and grass weeds are a problem and must be controlled during mild portions of the winter. In Montana frequent winterkill thins wheat stands.

Table 24--Pesticide use on wheat, 1987 1/

Crop & State	Acres treated with Herbicides	Acres treated with Insecticides
	Percent	
Winter wheat:		
Arkansas	14	3
California	66	4
Colorado	27	28
Idaho	89	9
Illinois	8	nr
Indiana	10	nr
Kansas	52	2
Missouri	5	1
Montana	90	3
Nebraska	21	nr
Ohio	7	nr
Oklahoma	45	4
Oregon	98	9
Texas	44	18
Washington	94	4
1987 average	48	7
1986 average	38	5
Spring wheat:		
Idaho	83	nr
Minnesota	98	2
Montana	85	37
North Dakota	92	1
South Dakota	72	nr
1987 average	89	7
1986 average	86	12
Durum wheat:		
North Dakota	95	3

nr = none reported.
1/ States in survey harvested 32.8 million acres of winter wheat (83 percent of U.S. total) in 1987, 14.1 million acres of spring wheat (99 percent of U.S. total) in 1987, and 2.9 million acres of durum wheat (88 percent of U.S. total) in 1987.

Table 25--Selected herbicides used in winter wheat production, 1987

Item	CA	CO	ID	KS	MT	NE	OK	OR	TX	WA	Area
						Thousand					
Acres treated with herbicides	315	682	713	5174	1990	405	2153	735	1584	1714	15465
						Percent					
Active ingredients:											
Single materials--											
2,4-D	46	33	33	35	33	86	26	9	60	22	35
MCPA	24	nr	6	2	2	nr	1	5	1	nr	2
Chlorsulfuron	nr	21	4	38	3	nr	61	21	23	13	27
Other	9	8	27	3	16	nr	4	47	12	15	11
Tank mixes --											
2,4-D + dicamba	nr	8	11	9	24	10	7	5	1	7	10
2,4-D + chlorsulfuron	nr	nr	nr	12	3	nr	nr	8	4	3	5
2,4-D + others	2	29	5	nr	9	10	1	10	4	9	5
MCPA + others	13	nr	22	nr	13	nr	nr	6	nr	19	5
Others	7	nr	9	2	5	nr	nr	17	nr	18	5
						Number					
Acres-treatment	1.0	1.0	1.2	1.0	1.1	1.1	1.0	1.3	1.1	1.1	1.1

nr = none reported

In the spring wheat and durum States, herbicide use ranged from 72 percent in South Dakota to 98 percent in Minnesota. Because the seedbed is prepared in the spring, a good medium is provided for both crop and weed germination.

Insecticide use was most important in the spring wheat area of Montana (37 percent) where grasshoppers were a problem. In Colorado (28 percent) and Texas (18 percent) Russian wheat aphids were the major insect pest.

Table 26--Selected herbicide use in spring wheat production, 1987

Item	Spring wheat						Durum
	ID	MN	MT	ND	SD	Area	ND
				Thousand			
Acres treated with herbicides	282	2363	1957	5596	1295	11493	2719
Active ingredients:				Percent			
Single materials--							
2,4-D	56	27	49	36	51	39	50
MCPA	nr	21	nr	20	5	15	15
Chlorsulfuron	7	nr	11	2	[illegible]	3	5
Diclofop-methyl	7	11	nr	[illegible]	2	7	5
Triallate	7	3	4	3	nr	3	12
Trifluralin	nr	2	nr	8	5	5	18
Other	23	2	2	13	2	12	8
Tank mixes--							
2,4-D + dicamba	[illegible]	3	21	[illegible]	29	12	10
MCPA + dicamba	2	5	[illegible]	5	2	[illegible]	3
2,4-D + others	16	6	14	[illegible]	2	7	3
MCPA + others	nr	13	nr	5	nr	5	1
Other	nr	11	nr	5	nr	5	10
				Number			
Acre-treatments	1.2	1.2	1.0	1.2	1.0	1.2	1.4

nr = [illegible] reported.

Herbicides were used on over 15 million winter wheat acres with an average of 1.1 applications per acre (table 25). 2,4-D was the most commonly used herbicide, with applications to 35 percent of the acreage. Chlorsulfuron was second in importance and was used on 27 percent of the acreage. The most commonly used tank-mix was 2,4-D + dicamba.

Herbicides were used on 11.5 million acres of spring wheat and 2.7 million acres of Durum (table 26). The most commonly used herbicide on both crops was 2,4-D. Trifluralin for foxtail and triallate for wild oat control were used to a greater extent in Durum production than spring wheat.

Regulatory Actions

Following is a summary of Special Reviews being conducted by the Environmental Protection Agency (EPA) for pesticides used in agriculture. The public is informed of the initiation of a Special Review with the publication of risk analyses, Position Document (PD) 1. EPA presents its proposed regulatory decision in PD 2/3. After a period of public comment and scientific review, a final position document (PD 4) is published, delineating EPA's actual regulatory decision.

Special Reviews by EPA

Common Name	Category	Major Use	Possible Risk	Status
Aldicarb	Insecticide, nematicide	Peanuts, potatoes, Cotton, citrus	Acute toxicity	PD 2/3, FY 88
Amitrole	Herbicide	Non-crop areas	Carcinogen	PD 2/3, FY 89
Captan	Fungicide	Apples, peaches, seed treatment	Tumors, birth defects	PD 4, FY 88
Chlorothalonil	Fungicide	Peanuts	Tumors	PD 1, FY 88
Carbofuran	Insecticide	Corn, peanuts, sorghum, sunflowers	Wildlife, bald eagles	PD 2/3, spring 1988
EBDC's	Fungicides	Apples, potatoes, tomatoes, citrus	Carcinogen, birth defects	PD 2/3, FY 89
Dinocap	Fungicide	Apples	Birth defects	PD 4, fall 1987
Linuron	Herbicide	Corn, fruits, vegetables	Carcinogen	PD 2/3, FY 88
Parathion	Insecticide	Wheat, sorghum, fruits	Acute human toxicity	PD 1/2/3, spring 1988
Phosdrin	Insecticide	Vegetables, fruits	Acute human toxicity	PD 1, FY 88

THE CONTINUING FIFRA CONTROVERSY: GENERIC ENTRY INTO THE PROPRIETARY CHEMICAL MARKET

by

Philip I. Szmedra

ABSTRACT: Recently proposed legislation would allow accelerated access for generic producers of pesticide products into markets with formidable barriers to entry. Basic chemical developers argue that allowing virtually free entry to previously proprietary markets would blunt necessary incentives to develop safer and more effective pesticide products. The generic industry counters that significant savings in the cost of pesticide inputs could be realized. Resolution of this contentious issue would help speed passage of long-awaited amendments to FIFRA deemed necessary by agriculture, the chemical industry, and environmental groups.

Despite the expectation that major changes in the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) were imminent in 1986, there has been no progress to date in amending the law that governs pesticide manufacture and use in this country. The irony of the current stalemate is that several of the most contentious issues preventing any progress are financial rather than environmental in nature. Separate factions of the agricultural chemical industry, including the National Agricultural Chemical Association, the Chemical Producers and Distributors Association, and the Chemical Specialties Manufacturers Association, have opposing viewpoints on issues which may alter the market structure of the industry in the years ahead.

Specifically, representatives of the generally small chemical formulators and distributors are arguing for the establishment of an abbreviated generic pesticide regulation system which would, to their thinking, stimulate competition and ultimately lower prices. Current patent law allows the developer of a technical product (active ingredient) 17 years of exclusive production rights in which to recoup research and development costs and to extract profits from the market assuming a successful product. The actual effective marketing period, however, is shortened by up to 7 years because of EPA regulatory requirements which mandate review of data submitted by the product developer documenting the product's toxicity to both man and the environment. This data review process is a prerequisite for marketing a pesticide product.

Generic producers may enter the market when the original patent expires. However, full EPA data review and registration is necessary for products using the same patented active ingredient. Generic producers have two options, either to develop their own set of data, duplicating the time consuming process undertaken by the original developer, or to buy the rights to the original data, allowing EPA to consult the data under which the initial registration was granted to determine the registrability of the generic product.

With no set framework for determining the value of proprietary data, the current law leaves the data compensation issue to be agreed upon by the parties involved or to be settled by binding arbitration. It is in the interests of the original developer to place a high price on the data in order to protect production rights. The single arbitration ruling decided to date (*Stauffer Chemical Company vs. PPG Industries*) resulted in what some industry representatives considered a prohibitively expensive settlement against the generic producer.

For this reason, generic producers have sought legislation allowing easier market access. House Bill 2569, introduced in June 1987, would amend FIFRA to allow potential registrants to submit "abbreviated applications" for the registration of generic

products or for new uses of existing pesticides. That is, after the patent expiration of a proprietary product, the generic producers would be required only to provide the EPA evidence of their ability to produce the technical product, rather than duplicating existing data or providing compensation for use of data on file. In exchange, generic producers are apparently willing to agree to a 5 year extension of patent protection. This would compensate for the marketing period loss caused by EPA's review of data documenting both the acute and chronic toxicity of the patented substance.

The generic industry contends legislative changes are needed to stimulate competition in the pesticide industry, lower the price of pesticides, and save American agriculture $400 million to $500 million per year for at least the next 5 years on agricultural pesticides alone. These figures are based on a projected 20-percent price decrease for products coming off patent and facing generic competition. Specific product examples include Butylate (patent expired 1984; price decrease of 10 percent since then), and Aluminum Phosphide (1982; 20 percent) (3).

Pesticide developers defend the present system as necessary to foster the development of safer, more effective, and more cost-efficient products (1). The research and development process for a marketable agricultural pesticide is tedious, time consuming, and costly. For example, usually only one of approximately 20,000 compounds screened for field use shows promise of becoming commercially viable.

A registrant company typically invests about $15 million over the 5 to 7 years necessary to develop the data to support a pesticide registration. The data required for registration include screening for biological, residual, metabolic, and toxicologic effects, as well as studies of the compound's ultimate effect on the environment. The average time from a compound's initial development through long-term field studies to submission for first commercial registration is 7 years. Pesticide developers argue that eliminating the data compensation provisions of the present FIFRA would erode research incentive. Many newly developed products tend to be more target-specific and less persistent in the environment than older products. The basic producers argue that product innovation would be jeopardized; that the continued flow of research dollars is required to develop safer pesticides.

Chemical and Pharmaceutical Industry Similarities

Under the present system, the ruling under binding arbitration determines the ability of generic chemical producers to enter a previously proprietary product market. The data compensation figure is either considered affordable, in which case entry occurs, or unaffordable, allowing the original developer to continue exclusive production and marketing. However, economic efficiency would suggest making market-entry conditions explicit, and eliminating the case-by-case arbitration process. This compromise approach is embodied in H.R. 1345, a bill which would extend the current patent term a uniform 5 years in exchange for free access to proprietary data.

The bill attempts to pattern the chemical industry after the pharmaceutical industry, where similar arguments were heard 4 years ago. At that time, the generic drug industry argued for easier access to the proprietary market, while proprietary drug firms said that a law of this type would undermine research and development incentive and result in fewer marketable products. Since 1984, however, pharmaceutical research expenditures have been increasing at an average rate of 12 percent per year (table 27). Gross pharmaceutical research monies have actually doubled since 1981. But the two industries are not strictly comparable in potential markets and subsequent profit margins, so inferring a similar trend in chemical research expenditures may be erroneous.

Table 27--Research and development expenditures in the pharmaceutical industry, 1981-1986

Year	Human and veterinary	Change from previous year
	Million dollars	Percent
1986	4,647	14
1985	4,078	14
1984	3,579	11
1983	3,218	16
1982	2,774	19
1981	2,340	9

Source: Pharmaceutical Manufacturers Association

Along with patent term restoration and accelerated registration, Congress eliminated the application of what has come to be called the Bolar/Roche decision as it applies to the drug industry. In April 1984, the U.S. Court of Appeals for the Federal Circuit ruled in *Roche Products, Inc. vs. Bolar Pharmaceutical Co.* that the use of a patented product by a second party to develop data for the purpose of obtaining an early market entry following the expiration of a patent was a violation of the use provisions of the law. The Court held that while there was an exemption for the use of a product for scientific purposes, the exemption did not apply when the information gained was for commercial purposes.

The decision effectively prohibited the manufacturer of a generic drug from developing, prior to the patent expiration, any data necessary for product registration. The effect of this decision is a de facto patent term extension of 5 to 7 years depending upon the volume of data required for a generic registrant. Section 202 of the Drug Price Competition and Patent Term Restoration Act of 1984 provides language to overrule Bolar/Roche as it applies to generic drug manufacturers. However, the FIFRA bills proposed to date contain a limited 2 year repeal rather than the full repeal the pharmaceutical industry obtained. The generic producers argue that nothing less than full repeal is adequate to allow the accelerated registration process for generic chemicals to truly take effect.

Economic Implications Of Patent Expiration

Spokespersons for the generic industry argue that price reductions of 20 percent or more could be expected based on the price movements of products that have recently come off patent. For instance, the price of atrazine, whose patent expired in 1976 selling at about $2.75 per pound of active ingredient, dropped to about $2.15 per pound in 1977. If a 20-percent across-the-board price reduction actually occurred, savings in pesticide costs for corn growers alone would run an estimated $270 million per year, or about $3.50 per acre (2). Further, once a product comes off patent, competitive pressure can be expected to drive the U.S. price toward the level of prices in world markets for products marketed worldwide. World market prices are generally lower than prices in the United States. The domestic pricing structure is more difficult to impose on the larger world market because patent laws are less stringent and more difficult to enforce than in the United States.

The ability to maintain different pricing structures for the domestic and international markets can be explained by what economic theory terms third-degree price discrimination. By being able to divide and effectively separate the market to take advantage of the differences in foreign and domestic willingness and ability to pay for a pesticide product, the producer with exclusive control over the pricing structure can maximize profits in both markets despite being unable to charge as high a price in foreign markets. However, actual overseas marketing conditions, which vary considerably by product and geographic region, determine profits from foreign sales of proprietary products and their contribution to monies available to fund ongoing research and development.

Many Products Coming Off Patent Soon

The issues of patent life and generic access into the chemical industry are especially relevant given that many popular pesticide products marketed both domestically and worldwide are coming off patent within the next 5 years (table 28). For instance, the latest available USDA figures on pesticide use indicate that alachlor (patent expiration 1987) comprised approximately 20 percent of the 475 million pounds of active ingredients applied to major field and forage crops in 1986; carbofuran (1986) about 10 percent;

Table 28—Pesticide products losing patent protection, 1987-1992.

Trade name	Common name	Original registrant	Patent expiration
Kerb	Pronamide	Rohm & Haas	1987
Lasso	Alachlor	Monsanto	1987
Bladex	Cyanazine	Shell	1987-88
Pretox	Ethiolate	Gulf	1987
Vydate	Oxamyl	DuPont	1987
Pirimor	Pirimicarb	ICI	1987
Tolban	Profluralin	Ciba-Geigy	1987
Previcur N	Propamocarb Hydrochloride	NOR-AM	1987
Benlate	Benomyl	DuPont	1988
Cobex	Dinitomine	US Borax	1988
Zorial	Norflurazon	Sandoz	1988
Bolstar	Sulprofos	Mobay	1988
Dowpon M	Dalapon-magnesium	Dow	1989
Modown	Bifenox	Mobil	1989
Orthene	Acephate	Chevron	1990
Basagran	Bentazon	BASF	1990
Roundup	Glyphosate	Monsanto	1991
Avenge	Difenzoquat	American Cynamid	1992
Prowl	Pendimethalin	American Cynamid	1992
Dimilin	Diflubenzuron	Thompson-Hayward	1992
Goal	Oxyfluorfen	Rohm & Haas	1992
Blazer	Acifluorfen	Rohm & Haas	1992

metolachlor (1993) about 5 percent. Significant price decreases for these chemicals would translate into substantial savings for American farmers.

Recent Pesticide Price Trends

Pesticide prices respond somewhat to market conditions. Farm demand for pesticides has recently declined because of farmer participation in commodity programs. Pesticide manufacturers have adjusted production to reduce available supplies and accommodate the decrease in crop acres planted. This type of action generally has a price maintenance effect.

However, aggregate herbicide prices have declined 13 percent, from $4.62 per pound (active ingredient) in 1982 to $4.05 in 1986, while insecticide prices have generally held steady at about $10 per pound. The decline in average herbicide price over this more recent period may be attributed to major products coming off patent. The price of atrazine dropped 25 percent between 1982 and 1985. Trifluralin, a herbicide used in soybean and cotton production whose patent expired in 1985, declined more than 25 percent during the same period. Though there are reasons other than loss of patent protection to explain these price movements, the opening of a product's market to competition is likely a significant factor in pressuring prices downward.

Overview and Implications

Segments of American agriculture have been under financial stress in recent years. Output has been at a reduced level because of near record acreage taken out of production under Government programs. Many rural communities heavily dependent on farm income have suffered economic loss because of this trend. Input industries have undergone a major consolidation to accommodate the changing markets.

The unique regulatory structure in which the basic chemical manufacturers and formulators operate, however, has provided a measure of insulation against these agricultural adjustments. Profit margins and research and development monies for basic chemical manufacturers have expanded at average annual rates of 8 and 6 percent

Table 29--Profits and research and development expenditures of selected chemical firms

Firms	After tax profits		R&D	
	1986	Annual change 1982-86	1986	Change 85-86
	Million dollars	Percent	Million dollars	Percent
Selected firms:				
American Cyanamid	202	7	278	11
Dow	741	5	605	11
DuPont	1538	11	1156	1
Monsanto	433	7	523	11
Pennwalt	51	3	45	14
Rohm & Haas	138	10	132	8
Other	1144	NA	923	NA
Industry total	4247	8	3662	6

NA = not available.

Source: Business Week, June 22, 1987.

respectively over the past 5 years (table 29). But only a portion of these profits and subsequent research expenditures can be attributed to their agricultural chemical markets. Therefore, drawing a strict analogy to the pharmaceutical industry experience in terms of continued R&D funding after the enactment of abbreviated registration legislation could be erroneous.

Patent protection has nurtured innovations resulting in a broad selection of pesticides to combat both actual and expected pest infestations. However, facilitating market access for generic production of established products through an abbreviated registration system would probably result in lower farmer production expenditures for these inputs, at least in the short run. The industry commitment to research expenditures will determine the long run price implications. The proposed legislative compromise restoring patent terms for basic producers and eliminating the data compensation provisions for generic producers may, however, solve the current legislative impasse.

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1. Committee for the Research and Development of Agricultural Chemicals, "FIFRA Fact Sheet". Submitted to the House Committee on Small Business, Subcommittee on Energy and Agriculture, June 24, 1987.

2. Shockey, Robert D., President, Chemical Producers and Distributors Association, in testimony before the House Committee on Small Business Subcommittee on Energy and Agriculture, June 24, 1987.

3. Stickle, Warren, Executive Director, Chemical Producers and Distributors Association, in testimony before the House Committee on Small Business, Subcommittee on Energy and Agriculture, June 24, 1987.

SEEDS

Seed use for major field crops in 1987 was 5.9 million tons, nearly 10 percent below 1986, as planted acreage fell (table 30). Small grains and corn were primarily responsible for lower seed use in 1987. Depending on farmers' reaction to 1988 farm program provisions, total field seed consumption will likely remain unchanged from last year. Anticipated increases in corn and soybean acreage are projected to offset decreased wheat seed consumption.

Seeding Rate and Seed Cost Per Acre

Seed cost per acre varies substantially by crop and by State and is determined by a combination of seeding rates and seed prices. In States where crops are irrigated or rainfall is abundant, the crops are more intensively farmed, which requires heavier seeding rates. For example, in California, where crops are typically irrigated, and in the eastern Corn Belt, where rainfall is ample, the seeding rate and therefore, the cost of seed per acre, tends to be higher than in other parts of the country. Also some States, such as California, tend to have higher seed prices.

Corn

The average seeding rate for corn in 1987 was nearly 24,000 kernels per acre, slightly higher than in 1986 (table 31). Average cost per acre, however, was $18.30, down 4 percent from 1986. Much of the difference apparently was due to lower seed prices last year.

The 10-State average plant population per acre was up in 1987, due, in large part, to an increased seed germination rate. Ideal 1987 spring growing conditions resulted in a 92-percent germination rate, compared with 89 percent in 1986.

The seeding rate and therefore seed cost varied considerably across the Corn Belt primarily due to soil productivity and available moisture. For example, Ohio had the highest seeding rate as well as the highest cost per acre, while South Dakota on the northwest fringe of the Corn Belt had the lowest rate and cost in each year.

Soybeans

The average seeding rate in both 1986 and 1987 was 59 pounds per acre, but the average cost per acre in 1987 was slightly lower, reflecting lower seed prices (table 32).

Soybean seeding rates tend to be lower in the southern States. Northern States, with higher seeding rates (and yields) exhibit greater seed costs per acre. Purchased soybean seed (versus home-grown or traded with neighbors) was used on an average of 73

Table 30--Seed use for U.S. major field crops

Crops	1981	1982	1983	1984	1985	1986	1987	1988 1/	Change 86-87
				Thousand tons					Percent
Corn	566	543	406	535	594	546	437	442	-20
Sorghum	56	56	50	64	56	48	45	42	-6
Soybean	1932	2037	1818	1932	1818	1770	1743	1770	-2
Barley and oats	845	958	1110	978	1072	1128	879	875	-22
Wheat	3390	3300	2910	3000	2790	2790	2520	2400	-10
Rice	255	220	160	165	140	130	130	150	0
Cotton	170	135	95	135	140	130	133	150	2
Total	7214	7249	6549	6809	6609	6542	5887	5829	-10

1/ Projected

percent of soybean acres in both years. The share of acres sown with purchased seed varied widely, ranging from a low of 59 percent in Minnesota to a high of 98 percent in Louisiana in 1987. In 1986, the range was 49 percent in Tennessee to 90 percent in Louisiana.

Cotton

In 1987, the average seeding rate and cost per acre of seed for cotton were up 5 percent and 8 percent respectively from a year earlier (table 33). In both years, Texas had the highest seeding rate and Louisiana the lowest. In all States except Texas, more than 80 percent of the cotton seed was purchased in both years. In Texas, 69 percent of the cotton acreage was planted with purchased seed in 1987 and 44 percent in 1986. The lack of good quality home grown seed in the spring of 1987 and a greater number of seed varieties covered under the Plant Variety Protection Act may account for the large year-to-year change.

Winter wheat

The average seeding rate per acre for winter wheat was 73 pounds in 1987, up 4 percent from 1986 (table 34). But the average cost was $6.20 per acre, down 14 percent from 1986, reflecting lower seed prices. States with consistently high seeding rates and costs were California, Ohio, Illinois, Arkansas, and Indiana. Colorado had the lowest seeding rate and cost. Overall, nearly 60 percent of the wheat acres are sown with home-grown seed. Increased use of bin-run seed in 1987 may reflect the economic stress experienced by some wheat farmers in these States.

Spring wheat

The average spring wheat seeding rate in 1987 was 88 pounds, similar to 1986. Seed cost per acre was $6.97, down 9 percent from 1986 (table 34). About half of all spring wheat acreage is planted with purchased seed, although considerable variation occurs among States and years.

Durum wheat

The seeding rate in 1987 was 102 pounds, up 10 percent from 1986 and cost per acre was up 7 percent (table 34). The percentage of purchased seed acres increased from 33 in 1986 to 44 in 1987.

Grain sorghum

Grain sorghum is grown predominantly in four States (table 35). In 1987, the seeding rate varied from a low of 5 pounds per acre in

Table 31—Corn for grain seeding rates, plant population, and seed cost per [illegible] 1986-87 1/

States	1987			1986		
	Rate per acre	Plant population per acre	Cost per acre	Rate per acre	Plant population per acre	Cost per acre
	Kernels	Number	Dollars	Kernels	Number	Dollars
IL	25000	23700	18.78	24700	22300	19.87
IN	24500	21900	18.47	24000	21500	19.01
IA	24300	21800	19.05	24100	21600	19.44
MI	23300	21600	18.44	23200	20700	18.52
[illegible]	25100	22700	19.59	25100	22800	20.44
MO	21300	18600	16.46	21000	17500	16.78
NE	23500	22000	17.48	23400	21100	19.03
OH	25800	22600	19.98	25600	22600	20.73
SD	18000	15800	13.37	18400	15800	14.45
WI	24200	22800	17.43	23700	21700	17.47
Average	24000	21900	18.30	23800	21300	19.09

1/ States in survey harvested 47.8 million acres of corn (80 percent of U.S. total) in 1987, and 55.5 million acres [illegible] percent of U.S. total) in 1986.

Table 32--Soybean seeding rates, seed cost per acre, and percent seed purchased 1/

States	1987			1986		
	Rate per acre	Cost per acre	Acres with purchased seed	Rate per acre	Cost per acre	Acres with purchased seed
	Pounds	Dollars	Percent	Pounds	Dollars	Percent
AL	48	8.34	83	51	8.95	77
AR	54	7.72	69	52	7.5	64
GA	48	8.54	85	48	8.83	73
IL	61	10.83	74	61	11.65	70
IN	60	10 12	79	59	9.56	75
IA	57	10.63	74	59	11.91	[illegible]
KY	53	7.69	60	53	7.91	71
LA	52	9.90	98	56	10.98	90
MN	64	9.78	59	64	10.39	73
MS	52	7.85	[illegible]	50	8.04	76
MO	59	9.25	71	59	9.31	74
NE	59	11.15	66	58	11.54	73
NC	55	10.48	65	53	10.03	80
OH	77	13.05	70	75	12.95	57
TN	46	7.06	64	50	7.02	49
Average	59	10.05	73	59	10.44	73

1/ States in survey harvested 49.5 million acres of soybeans (87 percent of U.S. total) in 1987, and 51.7 million [illegible] (86 percent of U.S. total) in 1986.

Table 33--Cotton seeding rates, seed cost per acre, and percent seed purchased 1/

States	1987			1986		
	Rate per acre	Cost per acre	Acres with purchased seed	Rate per acre	Cost per acre	Acres with purchased seed
	Pounds	Dollars	Percent	Pounds	Dollars	Percent
AZ	14.23	7.12	98	14.01	7.39	86
AR	14.37	7.23	100	14.62	7.06	98
CA	17.44	10.42	93	17.61	9.76	93
LA	11.81	6.88	98	12.65	6.36	95
MS	13.86	9.28	90	13.30	6.96	94
TX	22.96	8.23	69	21.37	7.83	44
Average	19.09	8.46	81	18.13	7.81	68

1/ States in survey harvested 8 million acres of cotton (80 percent of U.S. total) in 1987, and 6.7 million acres (79 percent of U.S. total) in 1986.

Kansas to a high of 8 pounds in Missouri. Likewise the cost per acre ranged from a low of about $4.00 in Kansas to a high of nearly $6.00 in Missouri, varying directly with the seeding rate.

Seed Prices

Prices paid by farmers for corn, sorghum, and wheat declined 2 to 7 percent while soybean and cotton seeds increased modestly in 1987 as compared to 1986 (table 36). Since 1981, prices for several field seeds, especially wheat and soybeans, have fallen significantly as the price of the crop itself declined. Publicly produced varieties and the ability of farmers to use seed from their previous year's crop have also depressed prices. Hybrid corn and grain sorghum, which are typically derived from proprietary sources and must be purchased each year, have shown much greater price strength since 1981. Cotton seed prices have also risen as commodity prices and acreage planted have increased in the last few years.

Grass seed prices rose significantly in 1987 as acres in the CRP grew from slightly over 2 million in 1986 to nearly 16 million in 1987. The CRP is designed to take acreage out of production for 10 years and plant erosion-prone land to soil conserving crops. The goal is for CRP acreage to reach 45 million by 1990. Although either trees or grasses can be planted for the life of the 10-year contract, less than 15 percent of the CRP acres is likely to be planted to trees. The rapidly expanding demand for grass seed

Table 34--Wheat seeding rates, seed cost per acre, and percent seed purchased 1/

States	1987 Rate per acre	1987 Cost per acre	1987 Acres with purchased seed	1986 Rate per acre	1986 Cost per acre	1986 Acres with purchased seed
	Pounds	Dollars	Percent	Pounds	Dollars	Percent
			Winter			
AR	127	10.80	65	121	11.39	61
CA	133	12.40	66	134	12.53	88
CO	47	3.70	27	43	3.29	27
ID	89	9.00	75	86	9.26	72
IL	108	12.60	72	103	12.47	72
IN	113	14.30	77	111	13.15	75
KS	63	5.20	31	63	7.00	34
MO	116	9.90	68	110	10.03	71
MT	58	5.10	19	59	5.28	30
NE	63	4.30	27	63	6.18	28
OH	132	14.50	62	127	14.45	63
OK	74	5.20	29	67	5.40	35
OR	80	7.60	61	76	7.87	66
TX	69	5.10	44	61	7.42	44
WA	65	6.20	71	70	8.07	76
Average	73	6.20	40	70	7.22	43
			Spring			
ID	98	12.09	72	105	14.93	71
MN	107	8.84	63	108	9.74	73
MT	63	5.09	39	66	5.83	38
ND	81	6.72	48	89	7.11	50
SD	91	6.79	44	87	7.43	40
Average	88	6.97	49	89	7.67	52
			Durum			
ND	102	7.62	44	93	7.13	33

1/ States in survey harvested 32.8 million acres of winter wheat (83 percent of U.S. total) in 1987, and 35.5 million acres of (82 percent of U.S. total) in 1986. States in survey harvested 14.1 million acres of spring wheat (99 percent of U.S. total) in 1987, and 13.3 million acres (96 percent of U.S. total) in 1986. North Dakota harvested 2.9 million acres of durum wheat (88 percent of U.S. total) in 1987, and 2.5 million acres (87 percent of U.S. total) in 1986.

Table 35--Sorghum seeding rates and seed cost per acre, 1987 1/

States	Rate per acre	Cost per acre
	Pounds	Dollars
KS	4.6	3.60
MO	8.0	5.90
NE	7.0	5.10
TX	7.2	4.70
Average	6.1	4.37

1/ States in survey harvested 8.1 million acres of sorghum (77 percent of U.S. total) in 1987.

Table 36--Prices paid by farmers for selected seeds for planting, 1981-87

Item	Unit	1981	1986	1987	Change 81-87	Change 86-87
		Dollars			Percent	
Field seeds:						
Corn	2/	3/ 56.00	66	64.9	16	-2
Grain sorghum	$/cwt.	49.40	67.00	63.60	29	-5
Wheat	$/bu.	7.22	6.00	5.56	-23	-7
Soybeans	$/bu.	14.00	11.00	11.30	-19	3
Cottonseed for planting	$/cwt.	40.60	47.00	48.10	19	2
Forage seeds:						
Red clover	$/cwt.	117.00	133.00	160.00	37	20
Fescue 1/	$/cwt.	65.40	67.00	107.00	64	60
Orchardgrass	$/cwt.	98.00	87.00	115.00	17	32
Ryegrass, annual	$/cwt.	37.00	36.00	45.10	19	25
Timothy	$/cwt.	98.20	78.00	107.00	9	37
Lespedeza, Sericea	$/cwt.	128.00	193.00	233.00	82	21
Alfalfa, certified	$/cwt.	218.00	219.00	222.00	2	1

1/ Tall, alta and Kentucky 31. 2/ Dollars/80,000 Kernels. 3/ Estimated.

in 1987 pushed many prices 20 percent or more above 1986 levels, stimulated increased forage seed imports, and increased North American certified grass seed acreage (tables 36 and 37). While certified grass seed is not required for CRP plantings, Federal and State conservation agencies recommend using certified seed when available, because stand establishment is enhanced. Fescue seed prices have risen nearly 60 percent in 1987 compared to 1986 while orchard grass and timothy seed prices are up over 30 percent. While imports and domestic production of grasses will likely expand, it is unlikely that prices will subside in the short run, particularly if the goal of 45 million CRP acres is to be met.

Seed Expenditures

In 1986, total farm seed expenditures fell 11 percent from the previous year to $3.5 billion (table 38). This was the second successive decline from a peak of $4.03 billion in 1984. The declines reflect reductions in planted field crop acreage. The 1986 reduction in seed expenditures was totally accounted for by field crops and small grains, which declined 15 percent from 1985. Partially offsetting this decline were increases of 5 percent in legumes, grasses and forages, and 3 percent in seeds and plants for other crops. In 1987, seed expenditures fell an estimated 13 percent from 1986 due to declines in planted acreage and price declines. Forecasts for a 2 4 percent increase in seed expenditures in 1988 reflect stabilizing seed prices and a modest increase in planted acreage for those crops whose seeds are purchased rather than saved from the previous year's crop.

Table 37--Acres applied for certification for selected grass seeds 1/

Item	1984	1985	1986	1987	Change 86-87
	Thousand				Percent
Timothy	36.4	58.4	32.1	74.9	133
All fescue	57.6	51.5	56.7	71.7	26
Tall fescue	22.0	26.0	38.8	47.6	23
Ryegrass	58.0	41.9	48.7	59.1	21
All bromegrasses	9.8	9.8	10.8	15.2	41
Orchardgrass	9.2	15.7	14.5	12.8	-12
All wheatgrasses	5.1	5.4	9.6	12.9	34
Other 2/	3.8	4.3	4.3	6.2	42

1/ U.S. and Canadian acreage. 2/ Other grasses commonly recommended for cover on CRP acres include: switchgrass, bluestems, blue grama, side oats grama, crown vetch, lespedeza, indiangrass, and needlegrass.

Source: Association of Official Seed Certifying Agencies.

Trade in U.S. Seeds for Planting

Exports

Exports of U.S seeds for planting have been expanding in value and volume almost continuously over the last 10 years. U.S. seed exports have enjoyed a competitive advantage in the international market because of inherent strengths of the domestic seed industry.

The export strength stems from: a diversity of agro-climatic conditions that allows production of a wide variety of crop seeds; a sophisticated industry that produces seed relatively free of disease, insects, and other contaminants and maintains the physiological quality of seed; a marketing staff familiar with a wide array of regulatory, packaging, shipping and other legal requirements; and large domestic markets that have helped establish a public and private research infrastructure for breeding new hybrids and varieties. The recent surge in exports also reflects the declining value of the dollar since early 1985, which has made U.S. products increasingly attractive to foreign buyers.

Table 38--U.S. farm expenditures for seeds 1/

Item	1981 2/	1982	1983	1984	1985	1986	Change 85-86
			Billion dollars				Percent
Field crops and small grains	3.07	2.87	2.66	3.21	3.17	2.70	-15
Legumes, grass and forages	.38	.31	.41	.40	.37	.39	5
Seeds and plants for other crops	.43	.50	.36	.37	.36	.37	3
Other seed expenses 3/	.05	.03	.06	.05	.04	.04	0
Total seed expenditures	3.93	3.71	3.49	4.03	3.94	3.50	-11

1/ Excludes bedding plants, nursery stocks, and seed purchased for resale. 2/ For 1981-1983, landlord expenditures included in the total but not for individual items. For 1984-1986, landlord expenditures included in individual items and total. 3/ Includes seed treatment.

In calendar 1986, U.S. exports of seeds for planting increased 3 percent to a record $371 million, following an 11-percent rise in 1985 (table 39). The 1986 increase was primarily due to forages, vegetables, and soybeans, which advanced 25 percent, 7 percent, and 12 percent respectively. These gains were partly offset by declines of 14 percent each in the exports of corn and grain sorghum. Flower seed exports also rose sharply although their contribution to total exports was relatively modest.

Italy, Mexico, Japan, Canada, France, and the Netherlands have traditionally accounted for over 50 percent of the total value of U.S. seed exports (table 40). Fifteen of 115 importing countries accounted for 78 percent of the total 1986 U.S. seed exports. Italy was the leading export market with purchases of $47 million (13 percent of the total), followed by Mexico (12 percent), and Japan (10 percent). In 1985 and earlier years, Mexico was the largest market, with Italy, Canada, or Japan in second place. Saudi Arabia has, intermittently, become a major seed customer as it seeks to produce rather than import agricultural commodities. On a regional basis, Western Europe, Asia, and North and Central America typically account for over 80 percent of the total export value.

Imports

U.S. imports of seed for planting in calendar 1986 totaled $112 million (table 39).

Table 39--U.S. seed for planting exports and imports 1/

Item	1982	1983	1984	1985	1986	Change 85-86
	Million dollars					Percent
Exports:						
Forage	66	65	70	59	74	25
Vegetables	115	122	135	135	145	7
Flower	5	6	[illegible]	8	9	13
Corn 2/	55	73	46	89	77	-14
Grain sorghum	28	32	33	33	29	-14
Soybeans	22	12	19	17	19	12
Trees/shrubs	2	2	2	2	2	0
Sugarbeet	4	4	3	2	2	0
Others	8	14	5	13	14	8
Total	305	330	322	358	371	3
Imports:						
Forage	17	34	17	18	39	117
Vegetables	31	31	32	34	42	24
Flower	12	10	18	18	[illegible]	0
Corn 3/	12	6	22	14	9	-36
Trees/shrubs	1	1	1	1	1	0
Others	3	2	1	2	3	50
Total	76	84	91	87	112	30
Trade balance	229	246	231	271	259	-4

1/ Totals may not add due to rounding. 2/ Not sweet, not food aid. 3/ Certified.

Source: Foreign Agricultural Service.

Import value climbed 30 percent above the previous year with forage seeds accounting for most of the increase. Increased demand (and prices) for forage seed due to the CRP likely encouraged the surge in imports. Domestic seed producers did not have the capacity, in the short run, to meet the sudden growth in demand. Vegetable and flower seed imports also rose from the previous year, but imports of certified corn dipped 6 percent as domestically planted corn acreage fell more than 8 percent from 1985.

The largest share (35 percent) of seed imports came from Canada, followed by the Netherlands, India, Japan, and Taiwan (table 41). In recent years the Netherlands and Japan have increased their share of imports at the expense of Mexico and India. Among regions, the largest share of seed imports

Table 40--Export values for U.S. seeds for planting, region and country share 1/

Region/Country	1982	1983	1984	1985	1986
			Percent		
Africa:					
South Africa	2.0	2.3	1.3	0.8	1.2
Egypt	0.8	1.0	1.2	1.0	0.6
Others	1.3	1.2	2.1	1.1	1.3
Total	4.1	4.5	4.7	2.9	3.2
North and Central America:					
Canada	9.5	8.8	8.9	7.4	6.3
Mexico	18.0	21.9	19.6	15.1	12.3
Others	2.5	2.1	2.7	2.5	2.0
Total	30.0	32.8	31.2	25.0	20.7
South America:					
Chile	0.3	0.6	1.1	0.3	0.4
Brazil	1.7	2.0	1.0	1.1	1.1
Argentina	0.7	1.0	2.0	1.1	2.5
Colombia	1.0	1.2	1.4	0.8	1.0
Venezuela	2.4	1.9	2.2	2.9	3.0
Others	0.8	1.9	1.0	0.8	1.0
Total	6.9	8.0	8.8	7.0	9.0
Asia:					
Turkey	0.2	0.5	0.7	1.3	3.0
Iraq	0.4	2.1	3.3	2.5	2.2
Saudi Arabia	3.4	3.1	4.5	2.8	3.6
Japan	11.9	11.2	11.5	10.7	9.5
South Korea	0.5	0.7	1.5	0.8	0.9
Jordan	0.4	0.4	0.7	0.3	1.1
Others	4.0	3.3	4.3	3.5	3.6
Total	20.8	21.3	26.5	21.9	23.9
Western Europe:					
Denmark	1.1	0.9	0.7	0.6	1.0
United Kingdom	3.4	2.6	2.2	2.7	2.8
Netherlands	4.8	4.8	3.4	4.6	5.8
France	5.5	4.9	4.2	9.6	6.2
West Germany	2.7	2.0	1.7	1.8	1.7
Spain	1.5	1.0	1.2	1.4	1.6
Italy	10.2	8.5	8.3	12.5	12.7
Greece	2.3	1.7	1.4	1.9	2.3
Sweden	1.3	1.1	1.2	0.9	0.8
Switzerland	0.8	0.4	0.5	0.3	0.3
Others	1.4	1.8	1.5	1.3	1.3
Total	35.2	29.8	26.4	37.5	36.4
Eastern Europe:					
Hungary	0.4	0.1	0.1	2.9	0.6
Romania	0.2	0.2	0.2	0.3	0.5
Bulgaria	0.0	0.1	0.0	0.0	3.0
Others	0.2	0.7	0.1	0.1	0.7
Total	0.9	1.1	0.5	3.3	4.8
Oceania:					
Australia	1.7	2.2	1.5	2.0	1.6
New Zealand	0.4	0.4	0.4	0.4	0.3
Others	0.0	0.0	0.0	0.0	0.1
Total	2.1	2.6	1.9	2.4	1.9
Total	100.0	100.0	100.0	100.0	100.0

1/ Totals may not add due to rounding. Based on total exports from Table 39.

Table 41—Import values for U.S. seeds for planting, region and country share 1/

Region/Country	1982	1983	1984	1985	1986
			Percent		
Africa:					
Ethiopia	4.6	3.9	3.2	4.4	2.8
South Africa	2.2	1.4	1.8	0.9	0.5
Others	0.1	1.0	0.6	1.1	0.5
Total	7.0	6.3	5.6	6.4	3.9
North and Central America:					
Canada	26.7	44.3	26.1	26.6	35.2
Mexico	5.2	3.6	2.8	4.0	2.9
Costa Rica	3.8	2.7	4.6	4.8	2.6
Others	3.2	1.8	3.2	2.9	2.7
Total	38.8	52.4	36.7	38.3	43.4
South America:					
Chile	3.3	3.2	10.0	8.2	6.2
Others	0.9	0.2	0.3	1.0	0.8
Total	4.2	3.5	10.3	9.2	7.0
Asia:					
India	7.9	4.7	1.7	3.3	6.5
Japan	4.6	5.1	5.9	6.1	6.2
Taiwan	6.2	7.6	10.1	7.6	5.9
Others	2.0	2.0	3.0	2.0	3.0
Total	21.0	19.4	21.0	19.0	22.0
Western Europe:					
Netherlands	7.7	6.6	10.7	11.6	10.5
West Germany	2.6	0.7	1.3	1.4	2.1
Sweden	1.7	1.0	0.3	2.0	1.8
Others	7.4	5.6	4.4	6.0	4.2
Total	19.4	13.8	16.8	20.9	18.6
Eastern Europe:					
Romania	3.4	0.0	5.3	0.2	0.1
Others	3.6	0.2	1.9	1.7	0.4
Total	7.0	0.2	7.2	2.0	0.4
Oceania:					
Australia	1.2	1.3	1.3	2.2	1.8
New Zealand	0.5	1.3	0.7	0.8	2.6
Others	0.0	0.0	0.0	0.0	0.0
Total	1.7	2.6	2.0	3.0	4.3
Total	100.0	100.0	100.0	100.0	100.0

1/ Totals may not add due to rounding. Based on total imports from Table 39.

came from North and Central America, predominantly Canada, which accounted for 43 percent ($49 million) of the total. Asia was the second leading source with 22 percent ($25 million) and Western Europe was third with 19 percent ($21 million).

The U.S. trade surplus in seeds for planting amounted to $259 billion in 1986 compared with $271 million in 1985. The 4-percent decline in 1986 was due primarily to a surge of $21 million in forage seed imports.

FARM MACHINERY

Demand

Farm machinery expenditures are expected to hold steady in 1988 as farm financial conditions continue to improve. Expenditures for farm machinery in 1987 are estimated to have been slightly below the $4.7 billion of 1986 (table 42). Because farm machinery expenditures have fallen every year since their 1979 peak, even the stabilization of expenditures is good news for the farm machinery industry.

Unit sales of new self propelled combines and four wheel drive tractors in 1987 declined an estimated 10 and 19 percent, respectively. However, sales of over-99 horsepower (hp) two-wheel drive tractors likely ended the year approximately 7 percent higher, as some very successful dealer incentive programs dramatically increased unit sales in the later half of the year (table 43). Sales of other new farm machinery units remained relatively stable. Farm net cash income for 1987 is estimated to have reached a record $57 billion, due in part to the $5-billion increase in direct government payments, the decreases in operating costs stemming from the idling of an additional 8 percent of U.S. cropland, and the year's strong livestock market.

Stabilization of Land Values Helps Improve Farm Equity

Farm machinery expenditures are expected to be encouraged by an improved farm equity situation. The apparent stabilization of farm asset values and the expected continuation of farm debt reduction lowered the farm debt/asset ratio from 21.4 in 1986 to an estimated 18 20 in 1987. An August 1, 1987, survey of rural land appraisers indicated that 64 percent believed that land values were stable during the prior 3 months and 14 percent thought values had declined. Stable farm equity values and a continued fall in farm debt are expected to lower the 1988 debt/asset ratio to 17 19 percent.

Increases Expected In Farm Commodity Exports

Because the purchase of farm machinery is a capital investment, farmers' expectations of future commodity prices are an important factor in the investment decision. Most farmers realize that growth in commodity exports can stabilize falling U.S. commodity prices. Thus, improvements in commodity exports can lead to an increase in farm machinery investment.

The volume of U.S. agricultural commodity exports increased an estimated 17 percent in fiscal 1987 as generic certificates, the Export Enhancement Program, and marketing loans help increase the international competitiveness of U.S. commodities. These programs have raised

Table 42--Trends in U.S. farm investment expenditures and factors affecting farm investment demand

Item	1983	1984	1985	1986	Estimate 1987	Forecast 1988
			Billion dollars			
Capital expenditures:						
Tractors	2.61	2.54	1.94	1.51	1.3-1.5	1.4-1.7
Other farm machinery	4.74	4.68	3.66	3.19	2.9-3.2	3.0-3.3
Total	7.35	7.22	5.60	4.70	4.1-4.7	4.4-5.0
Tractor and machinery repairs	3.7	3.8	3.7	3.7	3.6-4.0	3.6-4.0
Trucks and autos	2.0	2.0	1.8	1.7	1.4-1.7	1.6-1.9
Farm buildings	3.3	3.3	2.3	2.1	2.0-2.2	2.2-2.4
Factors affecting demand:						
Interest expenses	21.4	21.1	18.7	16.9	14-16	13-15
Total production expenses	140	143	134	122	116-118	118-119
Outstanding farm debt 1/ 2/	205	204	188	169	152-156	139-143
Farm real estate assets 1/	798	694	607	559	550-570	560-580
Farm nonreal estate assets 1/ 2/	253	253	243	229	230-240	220-230
Agricultural exports 3/	34.8	38.0	31.2	26.3	27.9	32
Net farm income	12.7	32.0	32.3	37.5	45	40-45
Net cash income	37.1	38.8	47.3	52.0	57	50-55
Direct government payments	9.3	8.4	7.7	11.8	17	14-16
			Million acres			
Diverted acres 4/	78.0	26.9	30.7	44.2	69.6	na
			Percent			
Real prime rate 5/ 6/	7.0	8.1	6.8	6.1	5.4	3.5-5.5
Nominal farm machinery and equipment loan rate 7/	14.3	14.6	13.7	12.2	9/ 11.2	na
Real farm machinery and equipment loan rate 6/	10.5	10.3	10.5	9.9	8.3	na
Debt-asset ratio 8/	19.5	21.5	22.1	21.4	18-20	17-19

1/ Calculated using nominal dollar balance sheet data, including farm households for December 31 of each year. 2/ Net of CCC loans. 3/ Fiscal year. 4/ Includes acres idled through commodity programs and acres enrolled in the Conservation Reserve. 5/ Monthly average. 6/ Deflated using 1982 GNP Deflator. 7/ Average annual interest rate. From the quarterly sample survey of commercial banks: Agricultural Financial Databook, Board of Governors of the Federal Reserve System. 8/ Outstanding farm debt (including households) divided by the sum of farm (including households) real and nonreal estate asset values. 9/ Average of the first and second quarters of 1987.

na = not available

Table 43--Domestic farm machinery unit sales

Machinery category	Annual average 1978-80	Annual average 1981-84	1985	1986	Forecast 1987	Change 1986-87
			Units			Percent
Tractors:						
Two-wheel drive						
40-99 hp	62,818	42,131	37,847	30,848	30,000	-3
Over-99 hp	59,543	31,272	17,700	14,262	15,200	7
Four-wheel drive	10,276	6,385	2,912	2,037	1,650	-19
Grain and forage harvesting equipment:						
Self-propelled combines	29,834	16,805	8,411	7,660	6,900	-10
Corn heads	20,338	9,560	5,016	4,716	3,800	-19
Forage harvesters 1/	11,145	5,093	2,460	2,164	2,300	6
Haying equipment:						
Balers 2/	17,501	9,975	7,038	5,734	5,400	-6
Mower conditioners	23,392	14,954	11,243	10,898	11,200	3

1/ Shear bar type. 2/ Producing bales up to 200 pounds.

Source: Historical data are from the Farm and Industrial Equipment Institute (FIEI). All 1987 values are ERS forecasts.

some commodity prices in the short run and have helped lower stocks.

The fall in the value of the dollar can also help farm commodity exports as long as the dollar falls relative to the currencies of countries competing with the United States in agricultural exports. Thus, since it was only since 1987 that the U.S. dollar slipped in value relative to the Canadian and the Australian dollars, farmers have not gained much through currency changes in their competition with Canadian or Australian commodity exports.

On the negative side, a fall in the dollar's value relative to currencies of countries that export agricultural inputs to the United States can raise the prices of those inputs, thus increasing U.S. farm operating costs. For example, because the dollar has fallen relative to the currencies of Germany and Japan (both significant suppliers of under 100 horsepower tractors), prices of these units can be expected to rise. Therefore, the effect of a falling dollar on U.S. agriculture depend significantly on which currencies have appreciated.

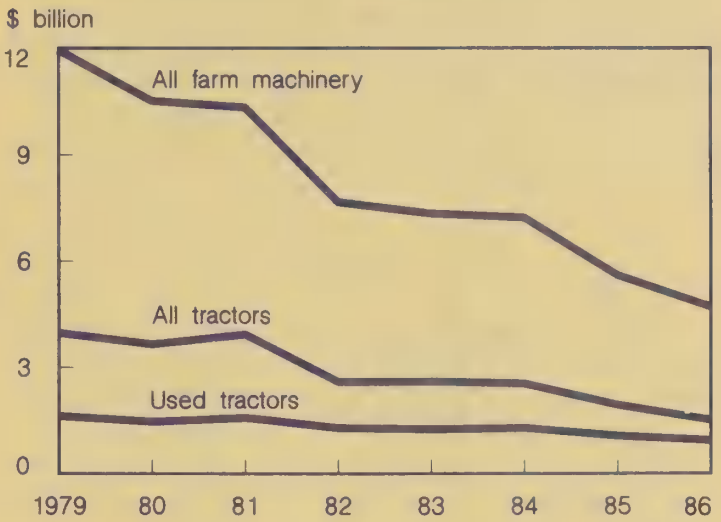
Less Land in Production

Demand for farm machinery in 1987 is believed to have been adversely affected as farmers idled 14.9 million additional acres under the Conservation Reserve Program (CRP) and another 10.5 million acres under other Government programs. The CRP is attempting to bid 45 million acres of the most erodible U.S. cropland out of production by 1990. The most recent signup for the CRP in July 1987 brought total contracted acreage to 23 million, roughly halfway to the program's goal. As crop acreage is removed from production, less farm machinery is needed by the sector and, thus demand is reduced. However, the acreage reduction programs helped support farm income. Direct government payments are estimated to have reached a record $17 billion in 1987. Higher farm income and improved farm equity act to increase farm machinery demand.

Expenditures for New Tractors Decline Significantly

Expenditures for farm machinery fell from $11.95 billion in 1979 to $4.70 billion in 1986, or about 60 percent. At the same time,

U.S. Farm Machinery Expenditures



tractor expenditures were falling at approximately the same rate, from $3.97 billion to $1.51. Between 1979 and 1986, expenditures for new tractors fell 76 percent while expenditures for used tractors fell 42 percent. Clearly, expenditures for used tractors remained more stable than expenditures for new tractors. Though specific data are not available, it is likely that expenditures for other farm machinery showed a similar trend in sales of new and used units.

Unit Sales

Sales of four-wheel drive tractors, self-propelled combines, and corn head units are estimated to be, respectively, 19, 10, and 19 percent lower in 1987 than in 1986. However, sales of these units were stronger in the later half of the year than the first half. Significant sales promotions on over-99 hp two-wheel drive tractors are estimated to have left 1987 unit sales 7 percent above 1986 levels.

Though sales of new forage harvesters weakened in the later half of 1987, sales for the year are estimated to be about 6 percent above 1986. Despite the strength in the cattle market, estimated sales of balers that produce bales smaller than 200 lbs. are expected to be off 6 percent in 1987, possibly indicating a continued shift toward use of larger balers.

Manufacturers will record 1987 as another year of falling demand for new farm machinery units. While unit sales increased for some machine categories, the gains

resulted, in part, from significant dealer incentives. Continued dealer incentives may be necessary in 1988 to maintain sales. Farmers who are in a secure financial position and plan to buy new machinery within the next 2 or 3 years would likely do well by taking advantage of whatever dealer incentives are offered in 1988.

Supplies

The farm machinery industry continued to bring inventory levels more in line with sales during 1987. Although production data are not available, it appears that even though unit sales during the previous 12 months declined roughly 6 percent, lower production rates for 40-99 hp (mid-size) two-wheel drive tractors enabled manufacturers to lower September inventories by 20 percent. As a result, the industry's inventory-to-purchase ratio (IPR) for mid-size tractors fell 15 percent in September 1987, compared with a year earlier (table 44). On the other hand, manufacturers were able to reduce inventories of over 99 hp (large-size) two-wheel drive tractors by 54 percent, despite an increase in production. This decline, coupled with a near 3-percent drop in the previous year's sales rate caused the September 1987 IPR to decline 52 percent from a year earlier.

Table 44--September inventories of over-40 hp wheel tractors, by horsepower category and total self-propelled combines

Machine category	1985	1986	1987	Change 86-87
		Months 1/		Percent
Tractors:				
Mid-size 2WD				
40-49	7.2	8.5	7.2	-15
50-59	9.1	9.3	7.3	-22
60-69	9.7	9.6	8.4	-13
70-79	8.4	8.8	9.7	10
80-89	8.5	10.2	7.9	-23
90-99	18.5	21.0	10.8	-49
Total	8.6	9.4	8.0	-15
Large-size 2WD				
100-119	10.9	17.2	13.3	-23
120-129	12.2	16.6	8.9	-46
130-139	12.1	9.5	1.8	-81
140-149	15.6	12.6	8.7	-31
160-169	13.8	12.1	4.7	-61
180-250	14.0	12.7	3.2	-75
Total	13.4	13.0	6.2	-52
Four-wheel drive				
170-199	18.5	13.0	14.7	13
200-249	17.5	12.0	7.8	-35
250-375	12.8	9.0	9.5	6
Total	16.9	11.4	10.7	-6
Self-propelled combines	11.0	7.8	10.0	28

1/ Months of inventory are derived by dividing current inventory by average monthly sales for the previous 12 months.

A 32 percent drop in total four wheel drive tractor stocks exceeded the fall in the sales rate which lowered the September IPR to a level equivalent to an 11 months supply. Conversely, manufacturers were not able to lower self-propelled combine inventories enough to offset the decline in the previous year's sales rate. As a result, the September IPR for self-propelled combines increased 28 percent from a year ago.

The decline in the September IPR for large-size two-wheel drive tractors is primarily attributable to a sales incentive program instituted by a leading manufacturer during third-quarter 1987. The program was designed to liquidate the manufacturer's existing inventory of over-99 hp models and allow for the introduction of a new tractor line. Not only did the program lead to a 189-percent surge from a year earlier in third-quarter sales, but it was a major factor in the sharp reduction of inventories (computed on an IPR basis) for every sub class of large two wheel drive tractors.

According to September IPR's, inventories for three of the six sub classes of large two-wheel drive tractors (130-139 hp, 160-169 hp, and 180-250 hp) were below the general 6-month industry supply target. Historically, the industry response to such a shortage has been to sharply increase capital expenditures and production activity. However, because of the sluggish nature of large tractor sales over the past several years, combined with the fact that sales incentive programs often distort the actual level of farm machinery inventories, only a modest increase in industry production activity is expected in 1988.

Farm Machinery Trade

The United States remained a net importer of farm machinery through third-quarter 1987 (table 45). In the third quarter, the U.S. farm machinery trade deficit grew 21 percent from a year earlier to $138 million. The growth was spearheaded by a near 5-percent increase in the value of imported farm machinery while exports increased only 3 percent. In general, the U.S. farm machinery trade situation was characterized by reduced export demand to the important traditional individual country

Table 45--Farm machinery trade situation 1/

Trade, area	January-September 1985	1986	1987	Change 2/ 86-87
	Million dollars			Percent
Exports to:				
Africa	71.7	52.4	48.7	-7.0
Australia	101.2	40.1	32.2	-20.0
Canada	611.5	518.5	520.0	0.3
Central America 3/	23.7	30.8	38.2	24.0
Eastern Europe	28.4	23.0	10.5	-54.0
Far East	32.9	39.7	43.3	9.0
Mexico	182.1	65.0	48.9	-25.0
Middle East	18.8	11.9	10.9	-8.0
Near East	9.4	6.5	9.0	39.0
Oceania	2.8	2.7	1.9	-30.0
Saudi Arabia	78.4	42.7	73.8	73.0
South America	73.6	93.6	98.9	6.0
Western Europe	187.3	227.7	253.1	11.0
Total	1421.8	1154.6	1189.4	3.0
Imports from:				
Africa	0.6	0.7	0.9	29.0
Canada	321.8	273.6	346.8	27.0
Central America 3/	6.1	5.6	9.7	73.0
Eastern Europe	16.9	15.5	23.8	54.0
Far East 4/	8.4	11.6	17.2	48.0
Italy	102.0	91.9	96.0	5.0
Japan	262.7	329.2	328.5	-0.2
Middle East	5.0	5.6	7.0	25.0
Near East	0.4	0.1	0.3	200.0
Oceania	12.1	11.1	13.1	18.0
South America	9.9	8.8	14.4	64.0
United Kingdom	160.6	185.6	172.4	-7.0
West Germany	171.0	205.4	181.6	-12.0
Western Europe 5/	137.6	125.1	116.8	-7.0
Total	1214.5	1269.1	1327.6	5.0
Trade balance 6/	207.3	-114.5	-138.2	21.0

1/ Includes finished machinery items, nonassembled machinery and parts. 2/ Percent changes rounded to the nearest whole number. 3/ Includes the Caribbean countries. 4/ Excludes Japan. 5/ Excludes Italy, the United Kingdom, and West Germany. 6/ Trade balance is slightly overstated due to rounding of country export and import totals.

markets, a growing reliance on regional and swing markets (i.e., countries that function as intermittent markets), and the re emergence of Canada as the leading foreign supplier of farm machinery to the United States.

In the traditional export markets (Canada, Australia, and Mexico) trade remained depressed through third-quarter 1987. Exports to Canada remained roughly unchanged from the first 9 months of 1986 at $520 million, while exports to Australia and Mexico fell nearly 20 and 25 percent, respectively. For both Canada and Australia, the lack of growth in the demand for large-sized farm equipment, in particular wheel tractors, explains a large part of the depressed demand for U.S.-made farm machinery. Meanwhile, the downturn in exports to Mexico can be directly pegged to an overall deterioration of the Mexican economy.

While Canada, Australia, and Mexico remain the most important individual country markets for U.S.-made farm equipment, Western Europe and to a lesser extent South America have emerged as important markets. Western Europe and South America account for 21 and 8 percent of the total value of U.S. farm machinery exports, up 8 and 3 percentage points from third quarter 1986. Yet, it took a 73-percent gain in the value of exports as of the first 9 months of 1987 to Saudi Arabia, a swing partner, to facilitate the improvement in the value of U.S. farm machinery exports over a year ago.

Through third quarter 1987, value of exports to Saudi Arabia totaled nearly $74 million, compared with $42.7 million a year earlier. The resurgence of export activity to Saudi Arabia resulted from an 86-percent increase in the value of irrigation equipment exports. Irrigation equipment accounted for 75 percent of the total value farm machinery exports to Saudi Arabia.

In the import sector, the first 9 months of 1987 were characterized by a 27-percent increase in the value of imports from Canada. Imports from Canada totaled $347 million, compared with $274 million a year earlier. The re emergence of Canada as the leading foreign supplier offset declines in the value of farm machinery imports from Japan (-0.2 percent), the United Kingdom (-7 percent), West Germany (-12 percent) and the rest of Western Europe (-7 percent), except Italy. Some of the upsurge in imports from Canada can be traced to a resumption of production activity by a major four wheel drive tractor manufacturer during third quarter 1987.

Wheel Tractor Trade

The most important component of U.S. farm machinery trade is the wheel tractor. Wheel tractors including parts (partially assembled and non-assembled components) comprise roughly 50 percent of the export value and 70 percent of the import value associated with U.S. farm machinery trade. Consequently, fluctuations in wheel tractor trade heavily influence the U.S. farm machinery trade balance.

In the early 1970's, the United States was a net exporter of farm machinery, in large part due to sales of over-99 hp wheel tractors and other high capacity equipment to Canada and Australia. During that time, the Canadian and Australian agricultural sectors were experiencing a period of growth similar to U.S. agriculture. Wheel tractors and parts make up 50 percent of the total value of U.S. farm machinery exports to Canada and Australia.

Concurrently, U.S. farm machinery manufacturers began to move production of 40-99 hp tractors to Western Europe to circumvent EEC tariff and non tariff barriers.

By establishing subsidiaries overseas, domestic manufacturers are able to penetrate markets that are, on average, three times the comparable American market. Market share data from the Agricultural Engineers Association and *Implement and Tractor* indicate that U.S.-owned foreign subsidiaries account for roughly 61 percent of the British wheel tractor market. Foreign subsidiaries also serve as transshipment points from which a U.S. company can reach other foreign markets that would otherwise be unattainable. The duty free status of farm machinery imported to the United States also was a major factor in manufacturers' decisions to relocate selected wheel tractor production capacity abroad.

In the case of the under 40 hp tractor and to a lesser extent the 40 99 hp tractor market, the strategy was modified to include contracting agreements with Japanese companies. Currently, every major domestic manufacturer contracts with a Japanese firm to produce under 40 hp wheel tractors to be sold under the domestic producer's nameplate.

The importance of wheel tractor trade to the total U.S. farm machinery trade situation is reinforced by the contribution of wheel tractor components and parts. Wheel tractor parts account for 66 percent of the wheel tractor export value and 55 percent of the value of wheel tractor imports. Initially, farm machinery manufacturers vigorously exported wheel tractor parts to Western European subsidiaries because of inadequate overseas production capacity. However, the value of parts exported has gradually declined over the past several years as more overseas production capacity has been established. This trend further erodes the farm machinery export base and thereby constricts the trade balance.

The number of wheel tractor models still in production and sold by the major domestic producers in the United States provides some insight into the current dynamics of the international wheel tractor market (table 46). In 1987, there were 130 models still being produced domestically or overseas and marketed in the United States. The United

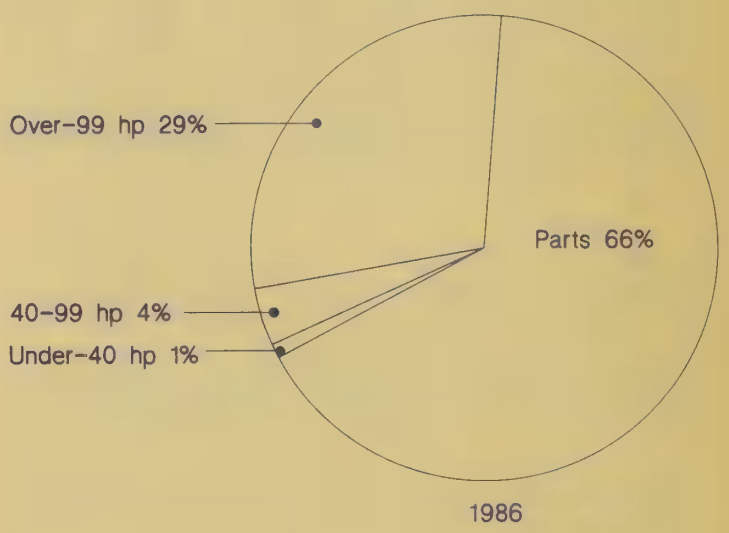
Table 46--Origin of wheel tractor models still in production and sold in the United States, 1987 1/

Origin	Under 40-hp	40-99 hp	Over-99 hp	Total
		Number		
United States	3	1	34	38
Canada	0	0	10	10
Mexico	0	1	0	1
Total North America	3	2	44	49
United Kingdom	3	13	1	17
West Germany	1	13	3	17
Italy	1	9	4	14
Belgium	0	0	4	4
Total Western Europe	5	35	12	52
Japan	23	6	0	29
Total	31	43	56	130

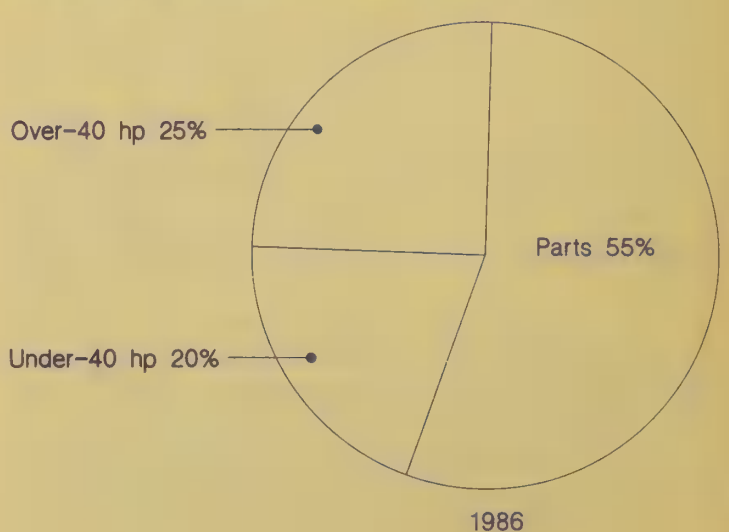
1/ Models reported are only those still in production and sold by the major domestic manufacturers.

Source: Stark's Off-Highway Ledger, J-C Communications, December 14, 1987

Value of Wheel Tractor Exports



Value of Wheel Tractor Imports



States produced 38 of these models while Western Europe and Japan produced 52 and 29, respectively.

Of the 38 models still in production in the United States, 90 percent were in the over-99 hp category. Meanwhile, Japan and Western Europe account for 74 and 81 percent of the compact and mid-size wheel tractor models still in production and marketed in the United States, respectively. Although these data do not indicate the total number of units sold in each model class, they do point out that a greater share of the tractor models still in production and sold in the United States are foreign-made.

The growth in compact tractor sales, smaller declines in unit sales of mid-size tractors compared to large-size tractors during the 1980's, and the lack of export demand for U.S.-made over-99 hp wheel tractors contributed to the recent farm machinery trade deficit. The deficit might have been considerably higher had it not been for weak domestic sales of compact and mid-size wheel tractors. Also, the fall in the value of the dollar undoubtedly helped to lower the value of farm machinery imports from Japan and West Germany. Based on current patterns of wheel tractor trade any turnaround in domestic sales of farm wheel tractors would likely translate into an increase in the U.S. farm machinery trade deficit.

ENERGY

U.S. farmers can expect energy prices to remain steady, and possibly edge downward during the first half of 1988 following sharply lower crude oil prices in the fourth quarter of 1987. Farm fuel energy prices increased 15 percent in 1987 in response to the crude oil price runup late 1986. Sharply lower crude oil prices in the last quarter of 1987, assuming no oil price shocks through 1988, should lower average petroleum product prices paid by farmers for all of 1988. Energy expenditures by farmers, which comprise about 4.5 percent of total U.S. energy expenditures, are projected to remain at last year's estimated level of $6.7 billion. Slightly lower energy prices are likely to offset a modest increase in energy intensive crop acreage such as cotton and rice, thus halting a 7-year decline in farm energy expenditures.

Oil Consumption and Production

OPEC's December agreement called for the twelve cooperating member nations to maintain their official price of $18 per barrel on crude oil for the first 6 months of 1988 and to extend the current ceiling on production. OPEC is now producing just under 19 million barrels per day, but demand for OPEC crude in the first 3 months of 1988 is expected to be only 17 million barrels per day, causing lower crude oil prices throughout 1988.

Preliminary Department of Energy forecasts indicate that, with low crude oil prices and economic growth between 2.0 2.5 percent, U.S. petroleum consumption will remain flat in 1988 (table 47). U.S. refiners paid an average of $18 per barrel in the last half of 1987, 25 percent over 1986 prices, but 33 percent below 1985. Prices dipped sharply in the last quarter of 1987, to $16.90 per barrel. The sudden fall in oil prices to below $17 per barrel underscores the fragility of the oil market, which had been experiencing relatively stable prices, following wide swings

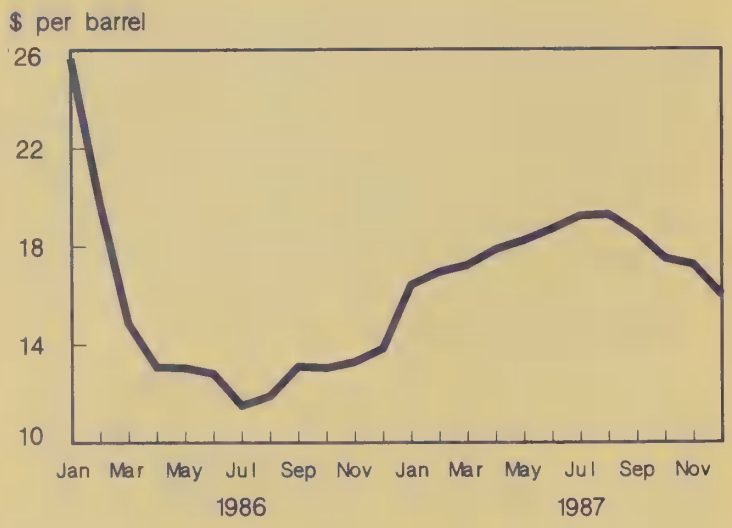
Table 47--U.S. petroleum consumption-supply balance

Item	1985	1986	1987	1988
	Million barrels per day			
Consumption:				
Motor gasoline	6.83	7.03	7.16	7.14
Distillate fuel	2.87	2.91	2.96	3.02
Residual fuel	1.20	1.42	1.25	1.22
Other petroleum 1/	4.83	4.92	5.17	5.12
Total	15.73	16.28	16.54	16.51
Supply:				
Production 2/	11.26	10.96	10.63	10.45
Net imports (excludes SPR)	4.17	5.39	5.65	5.99
Net stock withdrawals	0.22	-0.21	0.09	-0.01
Total	15.65	16.28	16.55	16.51
	Percent			
Net imports as a share of total supply	27	32	35	39
	Percent change from previous years			
Consumption		2.6	1.6	0.0
Production		-1.4	-5.1	-1.7
Imports		29.3	4.8	6.0

SPR = Strategic Petroleum Reserve 1987 October projections
1/ Includes crude oil product supplied, natural gas liquid (NGL), other hydrocarbons and alcohol, and jet fuel.
2/ Includes domestic oil production, NGL, and other petroleum products.

Source: U.S. Department of Energy. Energy Information Administration. Short-Term Energy Outlook, DOE/EIA-0202 8714Q). October 1987.

World Crude Oil Prices



in 1985 and 1986. Lower crude oil prices are likely to persist through next year.

Domestic production of crude oil and natural gas liquids fell again in 1987. Output of crude oil, currently less than 8.3 million barrels a day, has fallen to its lowest level in more than 20 years, increasing the United States' reliance on foreign oil. Imports increased 5 percent to 5.7 million barrels per day following a 29 percent increase the previous year (table 47). Imports in 1988 are expected to rise to 6.0 million barrels per day, the highest in 8 years. The share of total petroleum supplies attributable to net imports is expected to be 39 percent in 1988, up from 35 percent in 1987. Historically crude oil imports from OPEC countries have represented a significant share of total U.S. crude oil imports. It appears this share will be increasing in 1988. For the first time since 1978, imports of OPEC oil are likely to exceed 50 percent of U.S. crude oil and petroleum imports.

Energy in the Farm Sector

The U.S. agriculture sector's supply and price expectations largely reflect world market conditions, which are characterized by plentiful oil supplies and relatively low prices. Farmers can expect this favorable situation to continue in 1988. Energy expenditure trends over the last decade suggest that, for most crops, energy conservation was substantial, and that energy was used more efficiently.

Farm Fuel Use

On-farm use of gasoline, diesel fuel, and LP gas has been declining in recent years (table 48). Farm fuel use declined 9.5 percent in 1987 but is expected to stabilize in 1988 as increased planted acreage offsets the continuing shift from gasoline to more energy-efficient diesel-powered units.

Energy Prices Rose in 1987

Following sharp declines in farm gasoline, diesel fuel, and LP gas prices in 1986, average U.S. farm fuel prices rose in 1987. In October 1987, gasoline prices averaged 97 cents a gallon, up 18 percent from a year earlier. Diesel fuel prices rose 21 percent (table 49). USDA's October 1987 index of fuel energy prices rose 1.2 percent since July, up 14.7 percent from a year earlier.

Energy Expenditures In 1988 Stable or Up Slightly

In 1987, farm energy (gasoline, diesel fuel, LP gas, and electricity) expenditures fell an estimated 3 percent from 1986 to $6.7 billion (table 50). The falloff was due to reduced acreage as farmers participated heavily in various commodity programs, and to a lesser extent to energy conservation efforts. Falling crude oil prices realized in the last part of 1987 suggest that petroleum product prices paid by farmers are likely to decline through the spring. Lower energy prices in

Table 48--U.S. gasoline, diesel, and LP use per acre

Year	Crop acres 1/	Gallons of fuel 2/	Fuel use per acre
	Million	Billion	Gallons
1977	333	7.8	23.4
1978	336	8.1	24.1
1979	346	7.7	22.3
1980	356	7.2	20.2
1981	363	6.6	18.2
1982	359	6.5	18.1
1983	310	6.2	20.1
1984	345	6.1	17.4
1985	342	5.7	16.6
1986	328	5.4	16.5

1/ Principal crops harvested.
2/ Includes fuel used for drying, transportation, and livestock production.

1988 will likely be offset by a small increase in row crop acreage of energy intensive crops such as cotton and rice, resulting in energy expenditures similar to 1987. If this occurs there would be a reversal of the 7 year-long downtrend in energy expenditures by U.S. farmers.

Fuel Expenditures Differ by Crop

Energy use and expenditures (including fuel, lubricants, and electricity) per acre declined dramatically in the last decade (tables 48 and 51), but the changes varied sharply by crop. Factors influencing this downtrend included sharply higher fuel prices in the late 1970's and early 1980's and conservation measures which use fewer inputs per acre, such as reduced tillage.

Table 49--Average U.S. farm fuel prices 1/

Year	Gasoline	Diesel	LP gas
	Dollars per gallon 2/		
1977	.57	.45	.39
1978	.60	.46	.40
1979	.80	.68	.44
1980	1.15	.99	.62
1981	1.29	1.16	.70
1982	1.23	1.11	.71
1983	1.18	1.00	.77
1984	1.16	1.00	.76
1985	1.15	.97	.73
1986	.89	.69	.67
1987			
January	.85	.67	.62
April	.90	.70	.60
July	.96	.72	.56
October	.97	.75	.58

1/ Based on surveys of farm supply dealers conducted by the National Agricultural Statistics Service, USDA. 2/ Bulk delivered.

Table 50--Farm energy expenditures

	1985	1986	Preliminary 1987	Forecast 1988
	Billion dollars			
Fuels and oil	6.6	4.8	4.5	4.5
Electricity	2.2	2.1	2.2	2.3
Total	8.8	6.9	6.7	6.7
Percent change from preceding year		-22	-3	0

Among the crops shown in table 51, per-acre energy expenditures on sugarcane declined the most, falling an average annual rate of 7.0 percent, followed by sunflower at 6.5 percent, peanuts at 5.5 percent, and soybeans at 4.7 percent. Sugarcane and rice production required the largest energy expenditures on energy per acre, and wheat and flaxseed the least.

Real energy-related costs as a share of real variable cash costs also declined for all crops except sugarbeets, showing particularly steep declines for rice, cotton, wheat, barley, and sunflower. This suggests that, except for

Prices Paid for Fuel and All Inputs Purchased Off-Farm

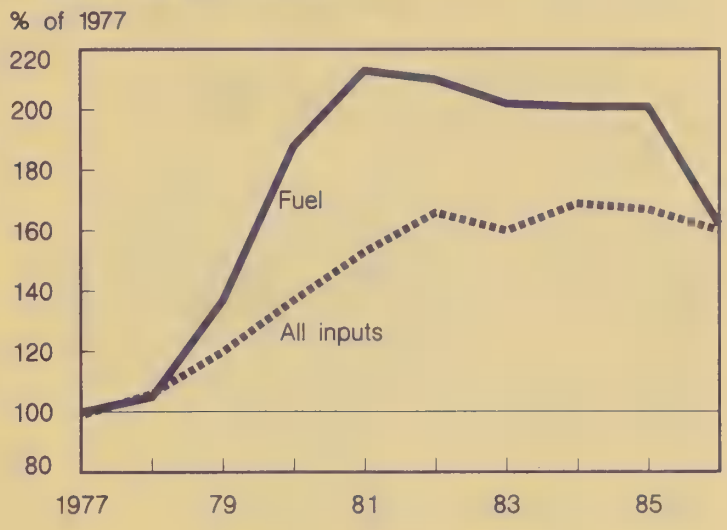


Table 51--Fuel, lubricant, and electricity expenditures per acre selected crops, 1977 dollars

Crop	Annual cost per acre 1/ 77-79	84-86	Share of variable cash costs 2/ 77-79	84-86
	Dollars		Percent	
Corn	7.80	6.40	10	8
Cotton	19.90	13.00	15	10
Wheat	4.90	4.20	18	14
Soybeans	5.80	3.60	14	11
Rice	22.70	17.80	15	12
Sorghum	8.40	6.70	21	18
Peanuts	20.80	11.70	10	7
Oats	4.70	3.40	19	14
Barley	6.60	4.30	20	14
Sugarbeets	3/ 20.40	19.20	10	12
Sugarcane	3/ 31.10	19.90	7	5
Sunflower	4/ 4.60	2.70	14	9
Flaxseed	3.30	3.10	19	17

1/ Fuel, lubricant and electricity expenditures deflated by a weighted index of prices paid by farmers for diesel fuel, gasoline, and LP. 2/ Cash costs deflated by index of prices paid by farmers for inputs with non-farm origin. 3/ 1981 to 1982. 4/ 1979 to 1981.

sugarbeets, use of energy (fuel, lubricants, and electricity) fell relative to other production inputs. An absolute decline in energy use per acre is consistent with trends in total farm fuel use (table 48). Also, a decline in use of fuel, lubricants, and electricity relative to other inputs is consistent with trends in input prices, which have risen more for energy than for other inputs over the last decade.

If the energy-embodied inputs (fertilizer and chemicals, plus drying expenses) are included in the calculation of energy expenditures, most crop production also showed a decline in overall energy expenditures (table 52). Sugarcane, rice, sugarbeet, and peanut production involved the largest declines with energy and embodied-energy expenditures falling at an average annual rate of 3 percent or more. And all crops except wheat, sunflower, and flaxseed showed some decline in energy expenditures per acre.

All crops showed absolute declines in expenditures on energy-embodied inputs, suggesting that farmers generally used a lower amount of energy per acre. However, trends in the share of expenditures on energy-embodied inputs compared to all inputs differed significantly by crop. In the case of corn, rice, peanuts, oats, barley, sugarbeets, and sugarcane, farmers also spent less on energy-embodied inputs relative to non-energy inputs in response to conservation measures and slightly higher prices for energy relative to other inputs. At the other extreme, farmers spent more on non energy inputs relative to other inputs for cotton, wheat, sunflower, and flaxseed. A clearer indication of trends in total energy expenditures would require examining only the energy component of fertilizer expenditures embodied in fertilizer (about 60 percent energy), chemicals (about 13 percent energy), drying, and for cotton, ginning. Nevertheless, the data generally suggest conservation of per acre fuel use in crop production. For most crops, this conservation has involved substitution of other inputs for fuel because of relative price change, and technological change and/or scale economics.

Energy Use in the U.S. Economy And Crop Production

Since 1977 U.S. energy consumption per constant (1982) dollar of GNP has declined steadily. In 1987 energy consumption was less than 20,000 BTU per dollar, down from 21,500 in 1983. Energy use per dollar of GNP is down about 25 percent since 1977. Another measure of energy consumption in crop production can be constructed by comparing fuel, lubricant, and electricity expenditures to crop output per acre (table 53). Farm expenditures for fuel, lubricants, and electricity have declined at a

Table 52--Energy and energy intensive inputs costs per acre selected crops, 1977 dollars 1/

Crops	Annual cost per acre 2/ 77-79	84-86	Share of variable cash costs 2/ 77-79	84-86
	Dollars		Percent	
Corn	57.00	52.10	72	68
Cotton	95.10	91.20	70	70
Wheat	16.00	16.50	58	56
Soybeans	22.20	20.10	56	59
Rice	91.50	65.20	60	45
Sorghum	26.60	25.30	68	67
Peanuts	120.40	91.70	56	53
Oats	11.00	9.50	45	41
Barley	19.30	17.70	59	57
Sugarbeets 3/	98.80	77.50	50	47
Sugarcane 3/	132.90	94.90	30	23
Sunflower 4/	16.10	16.60	51	56
Flaxseed	6.60	7.50	39	42

1/ Fuel, lubricants, electricity, agricultural chemicals, fertilizer, ginning and drying cash costs. 2/ Direct and indirect cash costs and total costs deflated by the index of prices paid by farmers for input with a non-farm origin. 3/ 1981 to 1982. 4/ 1979 to 1981.

Table 53--Fuel, lubricant, and electricity expenditures per dollar of crop output, 1977 dollars

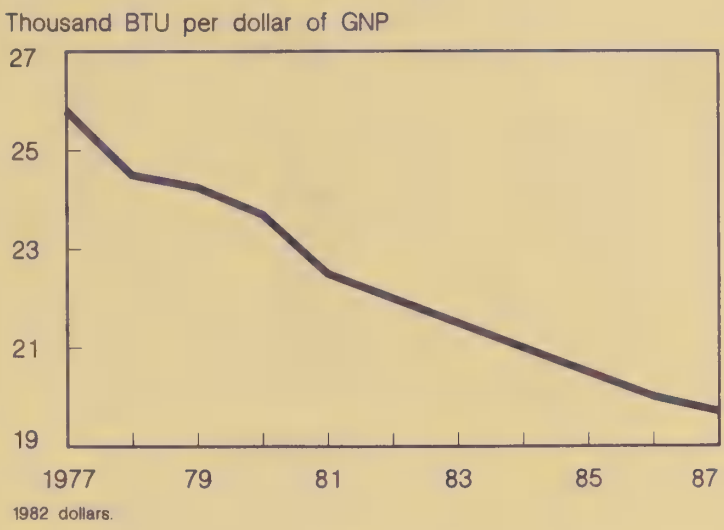
Crop	1977 to 1979	1984 to 1986	Decline
	Cents		Percent
Corn	3.7	3.2	14
Cotton	7.4	4.6	38
Wheat	6.2	4.6	26
Soybeans	3.0	1.7	43
Rice	6.4	6.2	3
Sorghum	7.5	5.9	21
Peanuts	3.8	1.4	63
Oats	7.6	5.1	33
Barley	7.4	5.1	31
Sugarbeets 2/	4.2	3.8	10
Sugarcane 2/	5.4	2.7	50
Sunflower 3/	4.1	2.4	40
Flaxseed	4.6	4.2	9

1/ Fuel, lubricant and electricity expenditures deflated by a weighted index of prices paid by farmers for diesel fuel, gasoline, and LP. Crop prices deflated by respective indexes of prices received by farmers for crops. 2/ 1981 to 1982. 3/ 1979 to 1981.

rate close to or exceeding the national average, suggesting considerable energy conservation in U.S. crop production. Peanut production exhibited the largest decline in energy consumption relative to output (63 percent), rice the least (3 percent). Cotton, soybeans, peanuts, sugarcane, and sunflowers showed declines of about 40 percent or more, far higher than the national average improvement in energy efficiency.

Wheat, sorghum, and barley showed declines in energy expenditures per acre relative to output of close to the national average. In contrast, corn, rice, sugarbeets, and flaxseed showed declines, but far lower than the national average, suggesting relatively little conservation in the use of fuel, lubricants and electricity in recent years. Most likely significant gains in efficiency were realized for these crops prior to 1977.

U.S. Energy Consumption



Appendix table 1--U.S. fertilizer imports: Declared value of selected materials for years ending June 30

Material	1985	1986	1987	1988 1/
		Million dollars		
Nitrogen:				
Anhydrous ammonia	414	348	230	96
Urea	259	299	249	49
Ammonium nitrate	55	55	33	5
Ammonium sulfate	32	26	20	5
Sodium nitrate	15	13	11	3
Calcium nitrate	13	11	12	5
Nitrogen solutions	21	27	30	7
Other	27	23	22	5
Total 2/	836	802	607	173
Phosphate:				
Ammonium phosphates	34	24	22	9
Crude phosphates	*	14	18	10
Phosphoric acid	*	*	*	*
Normal and triple superphosphate	1	*	3	4
Other	*	*	*	*
Total 2/	36	39	44	23
Potash:				
Potassium chloride	588	406	328	173
Potassium sulfate	12	9	9	3
Potassium nitrate 3/	11	15	8	2
Total 2/	611	430	345	179
Mixed fertilizers	27	22	20	2
Total 2/	1,510	1,292	1,016	378

* = Less than $1 million.

1/ Preliminary data for July-November 1987. 2/ Totals may not add due to rounding. 3/ Includes potassium sodium nitrate.

Source: (6).

Appendix table 2--Plant nutrient use by State for years ending June 30 1/

State, region	1986			1987		
	Nitrogen	Phosphate	Potash	Nitrogen	Phosphate	Potash
	Thousand tons					
Maine	12	10	10	13	10	11
New Hampshire	3	2	3	2	1	2
Vermont	6	5	7	5	4	6
Massachusetts	11	5	8	11	5	8
Rhode Island	2	1	1	2	1	1
Connecticut	7	4	5	7	4	5
New York	88	66	104	101	57	93
New Jersey	26	16	19	23	14	17
Pennsylvania	57	47	49	52	43	44
Delaware	17	7	14	17	6	14
Maryland	49	33	42	55	38	45
NORTHEAST	278	196	263	287	183	247
Michigan	248	143	243	237	132	233
Wisconsin	258	136	339	254	132	356
Minnesota	553	229	289	573	228	323
LAKE STATES	1,059	509	871	1,063	493	912
Ohio	405	206	346	373	179	308
Indiana	483	252	437	491	265	428
Illinois	947	461	706	841	374	618
Iowa	934	313	451	853	288	441
Missouri	348	148	224	332	150	226
CORN BELT	3,116	1,380	2,165	2,889	1,256	2,020
North Dakota	311	139	23	335	147	29
South Dakota	136	74	21	178	67	15
Nebraska	748	145	39	755	140	41
Kansas	545	140	33	528	132	27
NORTHERN PLAINS	1,739	498	115	1,797	487	112
Virginia	82	55	78	78	53	69
West Virginia	10	10	11	11	12	11
North Carolina	207	105	182	193	91	156
Kentucky	190	122	148	175	114	136
Tennessee	131	85	114	146	108	135
APPALACHIA	621	378	532	603	378	508
South Carolina	83	35	72	72	30	60
Georgia	219	101	158	193	85	132
Florida	225	93	233	278	123	262
Alabama	133	59	78	120	55	71
SOUTHEAST	659	288	542	662	294	525
Mississippi	170	61	80	152	39	52
Arkansas	208	54	79	206	52	78
Louisiana	179	48	66	152	41	54
DELTA STATES	557	164	225	511	132	184
Oklahoma	261	86	32	271	95	28
Texas	704	212	110	750	210	105
SOUTHERN PLAINS	965	298	142	1,022	305	133
Montana	82	62	10	101	60	11
Idaho	158	60	15	202	77	25
Wyoming	19	8	1	23	4	0
Colorado	155	30	12	154	37	10
New Mexico	34	13	7	30	9	5
Arizona	79	25	2	81	23	2
Utah	26	12	2	25	12	2
Nevada	4	2	0	5	6	0
MOUNTAIN	557	213	49	622	229	54
Washington	194	50	34	203	47	31
Oregon	137	39	24	126	34	28
California	508	148	60	533	161	68
PACIFIC	840	237	118	862	242	126
48 States and D.C	10,391	4,159	5,021	10,317	3,998	4,822
Alaska	2	1	1	2	1	1
Hawaii	19	12	19	16	9	17
Puerto Rico	13	5	13	13	6	12
U.S. TOTAL	10,424	4,178	5,053	10,349	4,013	4,852

* = Less than 500 tons. 1/ Totals may not add due to rounding.

RELIABILITY OF ESTIMATES

Fertilizer use in Appendix tables 3 through 7 is based on farm surveys taken during June, July, and August. These surveys are subject to sampling and non-sampling type errors that are common to all surveys.

To assist users in evaluating the reliability of the fertilizer application rate estimates in this report, a coefficient of variation range is shown for each nutrient by state. The coefficient of variation (CV) is computed by dividing the standard error of the estimate by its mean and expressed as a percent. One * indicates that the CV is greater than 10 percent and two **'s indicate that the CV is greater than 20 percent.

For example, the 10-state average nitrogen application rate per acre was estimated at 132 lbs. with a CV of 1 percent. This means that chances are 2 out of 3 that nitrogen use per acre will not be greater than 133.3 or less than 130.7 pounds. A higher CV indicates greater variability in the estimate. Nebraska's P_2O_5 use per acre on corn was estimated at 41 lbs. with a CV of 10 percent. Chances are 2 out of 3 that the P_2O_5 use per acre will not be greater than 45 lbs. nor less than 37 lbs. In the case of Missouri's per acre nitrogen use on soybeans, the mean was estimated at 15 lbs. with a CV of 33 percent which translates into a range for the true mean of between 5 and 20 lbs. 2 times out of 3.

Appendix table 3--Fertilizer use on corn, 1987

State	Acres for harvest	Fields in survey	Acres receiving				Application rates			Proportion fertilized		
			Any fertilizer	N	P_2O_5	K_2O	N	P_2O_5	K_2O	At or before seeding	After seeding	Both
	Thousand	No.	Percent				Pounds			Percent		
Illinois	9,200	241	98	98	88	85	161	82	110	79	2	19
Indiana	4,750	181	98	98	91	84	136	65	107	57	2	41
Iowa	10,050	207	98	98	84	82	132	58	73	79	3	18
Michigan	1,950	104	98	98	94	93	121	60	104	57	1	42
Minnesota	5,000	177	95	95	87	85	121	49	65	78	2	20
Missouri	2,150	123	96	95	81	82	134	57	73	82	6	12
Nebraska	6,200	206	97	97	63	35	135	41*	16*	66	5	30
Ohio	3,000	164	99	98	96	94	143	76	109	53	1	47
South Dakota	2,700	124	73	73	49	18	68	38	20	86	5	9
Wisconsin	2,850	157	99	99	97	96	89	56	82	74	0	26
10 State total	47,850	1,684	96	96	83	75	132	61	85	72	3	25

Appendix table 4--Fertilizer use on cotton, 1987

State	Acres for harvest	Fields in survey	Acres receiving				Application rates			Proportion fertilized		
			Any fertilizer	N	P_2O_5	K_2O	N	P_2O_5	K_2O	At or before seeding	After seeding	Both
	Thousand	No.	Percent				Pounds			Percent		
Arizona	308	84	95	95	39	na	159	70	na	18	56	26
Arkansas	640	101	99	99	75	79	81	43	63	41	11	48
California	1,120	259	93	93	26	na	115	60	na	20	38	42
Louisiana	600	92	100	100	68	71	74	47	55	46	29	25
Mississippi	1,090	162	100	100	48	60	106	52	71	43	13	44
Texas	4,250	543	57	57	46	23	51	37	14*	70	16	14
6 State total	8,008	1,241	76	76	47	33	82	44	45	49	22	29

na = not available.

Appendix table 5--Fertilizer use on sorghum, 1987

State	Acres for harvest	Fields in survey	Acres receiving				Application rates			Proportion fertilized		
			Any fertilizer	N	P_2O_5	K_2O	N	P_2O_5	K_2O	At or before seeding	After seeding	Both
	Thousand	No.	Percent				Pounds			Percent		
Kansas	3,700	208	91	90	48	13	67	35	29*	91	6	3
Missouri	770	84	92	90	74	74	95	51	64	71	9	20
Nebraska	1,220	135	88	87	19	na	80	30	na	89	8	3
Texas	2,450	296	74	74	51	13	95	36	20*	82	10	8
4 State total	8,140	723	85	85	47	17	79	37	40	86	8	6

na = not available.

Appendix table 6--Fertilizer use on soybeans, 1987

State	Acres for harvest	Fields in survey	Acres receiving				Application rates			Proportion fertilized		
			Any fertilizer	N	P_2O_5	K_2O	N	P_2O_5	K_2O	At or before seeding	After seeding	Both
	Thousand	No.	Percent				Pounds			Percent		
Alabama	500	88	67	44	66	66	18*	46	54	100	0	0
Arkansas	3,350	133	23	8	22	23	18**	44	62	100	0	0
Georgia	800	75	76	51	72	75	20*	38	68	95	5	0
Illinois	8,750	182	27	9	20	26	39**	57	105	98	0	2
Indiana	4,350	107	50	30	41	45	14*	46*	66*	94	6	0
Iowa	8,050	157	18	10	15	17	13*	45	55*	89	11	0
Kentucky	1,020	94	49	28	46	45	23*	61	71	100	0	0
Louisiana	1,660	99	17	7	17	15	15*	51*	78*	100	0	0
Minnesota	4,700	100	13	9	11	12	17**	26*	51**	92	8	0
Mississippi	2,450	111	24	10	23	24	10*	40	60*	100	0	0
Missouri	4,900	148	28	12	20	26	31**	43	67	95	5	0
Nebraska	2,350	77	12	12	10	6	15**	27*	15*	100	0	0
North Carolina	1,300	77	58	48	51	57	23*	45	80	100	0	0
Ohio	4,080	126	51	21	40	48	13	52*	96	97	3	0
Tennessee	1,250	96	49	20	43	48	20*	53	66	100	0	0
15 State total	49,510	1,670	30	15	25	28	20	47	75	97	3	0

Appendix table 7--Fertilizer use on wheat, 1987

State	Acres for harvest	Fields in survey	Acres receiving				Application rates			Proportion fertilized		
			Any fertilizer	N	P_2O_5	K_2O	N	P_2O_5	K_2O	At or before seeding	After seeding	Both
						Winter wheat						
	Thousand	No.	Percent				Pounds			Percent		
Arkansas	840	71	93	93	33	30	103	42	50	3	66	31
California	480	70	81	82	17	na	106	42*	na	49	16	35
Colorado	2,500	88	66	66	10	na	37	25**	na	88	7	5
Idaho	800	92	95	95	51	7	90	33*	22**	32	34	35
Illinois	950	78	99	97	79	76	88	76	94	18	22	60
Indiana	600	60	100	100	85	82	73	60	75	9	15	76
Kansas	9,900	244	87	86	49	2	54	33	14**	70	7	23
Missouri	770	74	98	96	53	51	87	46	57	25	50	25
Montana	2,200	105	69	69	54	6	45	29	9*	67	15	18
Nebraska	1,950	100	70	70	16	na	56	40*	na	82	14	5
Ohio	800	76	95	93	89	87	71	71	73	15	14	71
Oklahoma	4,800	165	89	89	47	1	64	35	19*	50	14	37
Oregon	750	102	96	96	14	9	72	37	49**	62	21	17
Texas	3,600	181	69	69	57	59	90	52	49*	51	24	25
Washington	1,825	164	98	98	37	3	69	21	26**	86	4	10
15 State total	32,765	1,670	83	83	43	13	65	40	58	58	15	27
						Spring wheat						
Idaho	340	53	85	85	42	na	98	43	na	69	4	27
Minnesota	2,400	64	88	88	78	64	83	33	27*	98	2	0
Montana	2,300	67	46	46	42	9	28**	27*	9**	94	6	0
North Dakota	6,100	109	84	84	76	14	53	29	17*	98	0	2
South Dakota	1,800	57	63	61	49	na	39*	29*	na	97	3	0
5 State total	12,940	350	75	75	66	21	56	30	22	96	2	2
						Durum wheat						
North Dakota	2,850	131	70	70	56	6	46	28*	13	97	1	2
						All wheat						
Arkansas	840	71	93	93	33	30	103	42	50	3	66	31
California	480	70	81	82	17	na	106	42*	na	49	16	35
Colorado	2,500	88	66	66	10	na	37	25**	na	88	7	5
Idaho	1,140	145	92	92	48	6	92	35	24**	42	25	32
Illinois	950	78	99	97	79	76	88	76	94	18	22	60
Indiana	600	60	100	100	85	82	73	60	75	9	15	76
Kansas	9,900	244	87	86	49	2	54	33	14**	70	7	23
Minnesota	2,400	64	88	88	78	64	83	33	27*	98	2	0
Missouri	770	74	98	96	53	51	87	46	57	25	50	25
Montana	4,500	172	58	58	48	7	38	28	9**	78	11	11
Nebraska	1,950	100	70	70	16	na	56	40*	na	82	14	5
North Dakota	8,950	240	80	80	70	11	51	28	17*	98	0	2
Ohio	800	76	95	93	89	87	71	71	73	15	14	71
Oklahoma	4,800	165	89	89	47	1	64	35	19*	50	14	37
Oregon	750	102	96	96	14	9	72	37*	49**	62	21	17
South Dakota	1,800	57	63	61	49	na	39*	29	na	97	3	0
Texas	3,600	181	69	69	57	59	90	52	49*	51	24	25
Washington	1,825	164	98	98	37	3	69	21	26**	86	4	10
18 State total	48,555	2,151	80	80	50	15	62	35	43	70	11	19

na -- not available.

Appendix table 8--Projected world supply-demand balances of plant nutrients 1/

World regions	Nitrogen		Phosphate		Potash	
	1987	1992	1987	1992	1987	1992
	Million metric tons					
Developed market economies:						
Supply	22.22	22.93	17.54	18.92	17.51	18.47
Demand	22.29	23.24	11.49	12.16	11.04	11.63
Balance	-0.07	-0.31	6.05	6.76	6.47	6.84
North America:						
Supply	10.80	11.05	9.22	10.58	10.99	11.56
Demand	10.05	10.65	4.21	4.50	4.70	5.10
Balance	0.75	0.40	5.01	6.08	6.29	6.46
Western Europe:						
Supply	10.29	10.67	5.37	5.33	5.32	5.20
Demand	10.75	11.00	5.14	5.20	5.30	5.39
Balance	-0.46	-0.33	0.23	0.13	0.02	-0.19
Oceania:						
Supply	0.33	0.51	1.31	1.39	0.00	0.00
Demand	0.36	0.41	1.04	1.21	0.28	0.33
Balance	-0.03	0.10	0.27	0.18	-0.28	-0.33
Other countries:						
Supply	0.80	0.71	1.64	1.62	1.20	1.71
Demand	1.13	1.18	1.10	1.25	0.76	0.81
Balance	-0.33	-0.47	0.54	0.37	0.44	0.90
Developing market economies:						
Supply	16.07	20.49	7.50	9.66	0.70	0.88
Demand	17.65	22.96	8.67	11.22	4.03	5.18
Balance	-1.58	-2.47	-1.17	-1.56	-3.33	-4.30
Africa:						
Supply	0.20	0.58	2.87	3.96	0.00	0.00
Demand	0.87	1.07	0.66	0.82	0.34	0.44
Balance	-0.67	-0.49	2.21	3.14	-0.34	-0.44
Latin America:						
Supply	4.05	4.89	1.66	2.16	0.02	0.09
Demand	3.50	4.89	2.60	3.20	1.73	2.25
Balance	0.55	0.00	-0.94	-1.04	-1.71	-2.16
Near East:						
Supply	3.25	4.14	1.28	1.50	0.68	0.80
Demand	2.74	3.40	1.51	2.10	0.14	0.18
Balance	0.51	0.74	-0.23	-0.60	0.54	0.62
Far East:						
Supply	8.58	10.88	1.70	2.05	0.00	0.00
Demand	10.54	13.60	3.90	5.10	1.82	2.31
Balance	-1.96	-2.72	-2.20	-3.05	-1.82	-2.31
Centrally planned countries of Asia:						
Supply	13.06	14.20	2.53	3.20	0.03	0.07
Demand	15.10	17.60	3.00	4.45	0.85	1.33
Balance	-2.04	-3.40	-0.47	-1.25	-0.82	-1.26
Eastern Europe and the Soviet Union:						
Supply	22.86	23.70	9.21	10.04	12.04	13.29
Demand	16.15	18.50	10.70	11.45	10.20	11.20
Balance	6.71	5.20	-1.49	-1.41	1.84	2.09
WORLD TOTAL:						
Supply	74.20	81.32	36.80	41.82	30.28	32.71
Demand	71.19	82.30	33.86	39.28	26.12	29.34
Balance	3.01	-0.98	2.94	2.54	4.16	3.37

1/ Forecasts for year ending June 30.

Source: (3).

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